

**USE OF EMYCIN TO TRANSFORM COMMUNITY-BASED  
SUSTAINABLE URBAN PLANNING SURVEY DATA**

A Dissertation

by

LINDA DIANE CLEBOSKI

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2008

Major Subject: Rangeland Ecology and Management

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## **ABSTRACT**

The Use of EMYCIN to Transform Community-based Sustainable Urban Planning

Survey Data. (May 2008)

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Chair of Advisory Committee: Dr. Douglas K. Loh

Use of the EMYCIN algorithms developed in early research on expert systems can be used to transform standard descriptive survey information into quantitative data that presents new information. The new data can be used to determine exact levels of approval or disapproval of community development proposals indicated in a one-number Index useful to compare and combine proposals for action to achieve high levels of community stakeholder approval. Descriptive survey responses from two opinion surveys were transformed using the EMYCIN technique into quantitative data, and results of the data transformation analyzed in comparison to results of the original descriptive survey data.

The EMYCIN technique applies a logical “weighting” system to each category of response for closed-ended survey questions offering “Yes/No/Neutral” responses or offering responses formatted in a 5-point and 7-point rating scale. The weighting system is based on the logical and equal divisions of a scale from  $-1$  to  $+1$ , with zero as the “Neutral” or inconclusive point. This weighting system takes the zero weight of “Neutral” and “Not Sure/No Answer” responses into consideration, so that every vote

case is represented in the calculation of a single numerical (quantitative) Index for each survey question response.

New information emerged from the data transformation. In the case of both surveys analyzed, new information emerged from calculation of the Range numbers, which proportionalize the total number of responses for each survey question to the number of “Neutral” and “Not Sure/No Answer” votes, and calculation of the Index numbers, which indicate the overall positive or negative weight of the total of responses for each survey question. The new information suggested that consultants’ reports of their interpretations of the original survey results were overly positive and general, and in some cases indicated higher levels of priority for an issue than was actually the case based on survey results. The potential usefulness of the Index numbers to community planners in creating new options for planning specific actions based on the opinions of survey takers through their raking, comparing and combining was shown.

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## CHAPTER I

### INTRODUCTION

Global population growth, trends in population movements, and the implications for future resource allocation and use have been recognized by many as indicators for the need for new and improved urban area planning. As a result of heightened global awareness of past failures to improve planning, new action programs have been initiated over the last few decades to address the need for improved ways to manage the impacts of expanding urban populations.

While many factors will influence cities' futures, it is clear to researchers, governments and global planners that new approaches to urban planning are called for given projected increases in the size and numbers of increasingly large urban growth centers in both developed and developing countries (Beatley and Manning 1997). For the first time in recorded history, there are more people living in urban areas than in rural areas on our planet, according to a June 5, 2007 United Nations press release documenting the first meeting of a new Global Platform for Disaster Risk Reduction (United Nations 2007)

The new urban planning is seen as moving forward, of profound necessity, from the old single-issue approaches, such as transportation or affordable housing, to more highly integrative paradigms that better address the complex of ecology, economy

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This dissertation follows the style of the *Journal of Planning Literature*.

and community and take into consideration the reality of global warming and new projections on changes required to respond to its anticipated impacts. These new planning approaches are sought to reinforce cities' natural advantages to serve large numbers of resource use and waste stream production (United Nations Center for Human Settlements 1996).

The recent emergence of "quality of life" as a criterion for evaluating the "livability" of a city has prompted the recognition by city governments and citizens of the need to participate in planning for future growth in order to achieve the desired future configuration of characteristics of a city. Many US cities have begun efforts to identify a broader picture of their futures that would serve to attract preferred types of growth and investment, respond to citizen preferences, recognize and address new and anticipated necessities for risk reduction, and maintain quality of services and quality of life for residents.

In fact, "quality of life" has become so broadly recognized as a way to rate and even rank cities competitively that Money Magazine, Sperling's Best Places on the Internet, Inc. Magazine, and other media organizations and outlets have developed annual polls and reviews to rank not only the quality of life in US cities, but also quality of other institutions such as undergraduate and graduate programs at US universities, "fatness or fitness" of US cities and universities, quality/desirability of US locations for investments, starting a new business or retiring, and many other "quality" rankings.

Out of the efforts of cities themselves to improve planning, community-based visioning has emerged as one viable first step in a new participative planning process

built on exchange of ideas among stakeholders about the future, identification of objectives and goals, and agreement on next steps to be taken to achieve a shared quality of life for the community. Visioning is defined in many ways, but can be simply described as a form of structured dialogue involving citizen groups, planners, local business leaders, elected officials, and other community stakeholders who join in “a series of community meetings and workshops, often leading to the development of a vision statement and a set of concepts and ideas” about where the community sees itself going in the future (Beatley and Manning 1997, 205). Focus areas are frequently separated into broad categories locally important to quality of life such as energy, environment, transportation, health, education, buildings, arts and culture, diversity, services, parks and recreation, green space, and others. A set of prioritized objectives may be developed and a list of actions to be taken to achieve the objectives may be produced and published at the end of the exercises.

Whether or not recommendations made by stakeholders during visioning projects are actually implemented is another issue. According to The National Civic League, many excellent, change-seeking community visioning projects formulate sets of recommendations and generate final reports that are filed away rather than placed in the hands of an implementation team (National Civic League 2000). Implementation of action recommendations may be influenced by many factors.

One factor important to the implementation of action recommendations is seen to be the format of the information arising from the visioning project, and the ability of stakeholders to compare and combine copious amounts of quantitative and descriptive

information in order to understand the issues raised, the possible development scenarios, and the potential costs and benefits from each proposed action.

#### **A. STATEMENT OF THE PROBLEM**

Community visioning leaders often use surveys to elicit stakeholder opinions of what issues are important to local quality of life, and to gain citizen responses on services and other issues already identified as important or insufficient in the community. In addition to allowing the collection of important economic, demographic and other important benchmark data, surveys offer the opportunity for assessing the intensity of negative or positive attitudes of stakeholders. Sets of questions requiring Yes/No answers, sets of alternatives from which to choose, and sets of questions offering ratings continuums or bipolar scales for responses are commonly used response formats for closed-ended questions in opinion surveys and community visioning exercises (Weisberg et al. 1996).

While most opinions can be placed in one of these general categories, and responses in each category fairly easily tabulated, the interpretation of survey results and, more importantly, development of recommendations for action to be taken based on these results, becomes highly subjective and depends on the perceptions, background, experience, skill, and authority to make assumptions, of the person or persons responsible for interpreting survey results. Even assuming that standardized statistical practices are used to tally and describe the survey results, a number of factors, including

widely varying survey structures and survey question designs, survey consultants' own personal and professional experiences, potential loss of data associated with "Neutral" and "No Answer" votes, application of different data "weighting" schemes, mapping to differing scales, and others influence the interpretation of survey results. However, in many cases, published survey results do not include descriptions of methodology used to arrive at the survey interpretation, and in fact the developers and users of many methodologies consider them proprietary. One could describe this data interpretation process as a "black box" process.

There does not appear to be a procedure for analyzing and interpreting quality of life visioning survey results that is transparent, replicable, incorporates all survey data, and promotes definition of action. A mechanism for transforming all the descriptive survey responses typically obtained from community opinion surveys into a logical quantitative scale that would allow more objective interpretation, ranking, and comparison of the weight/importance of responses, towards development of recommendations for stakeholder action, could be highly useful to visioning leaders and other key stakeholders in the process of planning for the future.

A rule base for a forest management expert system was designed by Loh et al. (1994) to accomplish much the same data transformation objective. Using this rule base, forest management options were ranked in a range from completely unfavorable to completely favorable, according to their outcomes, along a numerical scale from -1 to +1. A set of equations based on the EMYCIN algorithm (Buchanan and Duda 1983) is used in pair-wise calculations to determine the relative "weight" of favorability or



unfavorability contributed by each management scenario. This same approach of assigning value on a scale from  $-1$  to  $+1$  may be usefully applied to the transformation of community visioning survey results to enhance interpretation of results and develop a ranked set of options for action and funding.

## **B. PURPOSE OF THE STUDY**

The purpose of this study is to determine if a descriptive-quantitative mapping mechanism and the related EMYCIN algorithms can be used to transform descriptive data from citizen opinion surveys obtained in a community-based visioning project related to sustainability and quality of life into quantitative data that improves the objective interpretation of survey data and permits: 1) evolution of new information; 2) weighting or prioritizing of findings; and 3) combination of diverse recommendations.

Based on the problems identified, the study sought to answer the following research question: Can the EMYCIN algorithm be used to transform descriptive data obtained in community visioning project opinion surveys into quantitative data useful to leaders and stakeholders of the visioning process?

## **C. METHODS**

A city in Texas was identified as having completed several voter-based opinion surveys as part of a visioning project aimed at developing a General Plan for the city. A

general background overview of the visioning process in this city was conducted to understand broadly the history, participants, and process of this activity.

Three data collection techniques were utilized. Background documents of several organizations having participated in the development and management of the visioning project were acquired from the organizations' websites and reviewed to broadly document and understand the visioning process and the process of implementing the citizen surveys. Also obtained from the Internet were descriptions of the visioning processes and opinion survey evaluation methods of several other US cities, and the survey evaluation and interpretation methodologies used by a small sample of organizations and media outlets to develop "best city" rankings. Leaders of key organizations involved in the visioning project and the implementation of the opinion surveys were interviewed in confidentiality using broad open-ended questions and a few specific questions about the role of the organizations in evaluating and interpreting the survey results. Survey questionnaires, responses and summary reports were obtained from the organizations' websites and from interviewees within those organizations. The data collection process was emergent, such that data collected from all sources was used to further refine document reviews, to re-align interview questions if necessary, and to indicate other possible sources of evidence (Dooley 2002).

The summary reports containing the tabulation and interpretation of the survey responses were reviewed to determine the methodology used by survey consultants to analyze responses and develop conclusions from the survey results.

The EMYCIN data transformation technique was subsequently applied to the responses obtained in the two surveys. The new quantitative data was compared to the descriptive data from the surveys to determine the nature of new information arising from the application of the EMYCIN technique. The new quantitative data were then analyzed and manipulated through use of the EMYCIN technique to demonstrate the potential for usefulness of this new information.

#### **D. DELIMITATIONS**

The research study was delineated to results of actual surveys implemented as part of an ongoing visioning project in Texas.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **A. WORLD URBAN TRENDS**

The current world population of more than 6.4 billion people is increasing at the rate of about 90 million per year (Rees 1995) and is projected to increase to more than 7.9 billion by the year 2025 (Pirages 2005, 45). Since 1950, the world's urban population has grown from about 733 million to slightly more than 3 billion — that is, more than quadrupled (Mastney & Cincotta 2005, 29). Urban population represented approximately 40% of the world's population in 2005 and was growing at a faster rate than was world population (Ibid.). This current trend is expected to result in a global milestone in 2007: for the first time in history, the number of people living in cities is projected to exceed the number of people living in rural areas (Ibid.).

The downside of this mostly unplanned and rapidly increasing urban population growth has been recognized for decades and recently has become even more apparent. In 1800, London was the only city with one million people, and the largest 100 cities in the world held a total population of 20 million, the footprint of each city covering no more than approximately several thousand hectares. As of 1990, the world's 100 largest cities held a total population of 540 million, 220 million of whom lived in the 20 largest 'megacities'—those with more than 10 million residents—many of which covered hundreds of thousands of hectares. At least 35 cities in the world supported populations

of more than 5 million, and hundreds of cities claimed populations of over 1 million residents (Girardet 1999). According to a United Nations press release posted to their Web site, as of June 2007, the United Nations estimates that 50% of the world's population now resides in urban areas.

According to the Worldwatch Institute's 2005 State of the World Report, currently "16 of the world's 20 'megacities'...are in the developing countries, and the urban share of the developing world's population is projected to reach 60 percent by 2030, compared with 42 percent in 2003, and just 18 percent in 1950" (Mastney & Cincotta 2005, 31). These 'megacities' are characterized by overburdened or nonexistent power, transportation, waste disposal and other basic services infrastructure, inadequate job and housing markets, insufficient water and power, poor or nonexistent medical and other social services, depleted municipal budgets, heightened competition for land and other natural resources, rising poverty, and increasing urban unrest (Ibid.).

A similar trend is recognized from recent scrutiny of growth and development patterns in the United States. It is estimated that about 75% of Americans are concentrated in large cities (Blatt 2005, 1) and are driving an urban population growth rate that, at one percent per year, is higher than the national population growth rate, estimated by the US Central Intelligence Agency, in its online World Factbook, at 0.92 percent in 2005 (US Central Intelligence Agency 2005).

Scientists, governments, business and interested citizens decades ago recognized the need for better approaches to achieving sustainable balance between humanity-driven activities and the environment. This recognition prompted a series of global

national environmental congresses to address the issues. Starting with the 1972 United Nations Conference on the Human Environment in Stockholm, including the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil in 1992, and most recently, the 2002 World Summit for Sustainable Development in Johannesburg, South Africa, the need for new strategies for “redressing the balance” through poverty reduction and management of human activities to minimize negative environmental impacts has been made the focus of wide-ranging dialogue, status reporting, and calls for new policy and paradigms (Gardiner 2002).

## **B. EMERGENCE OF NEW URBAN PLANNING MODES**

It was not until 1992 that the need for new local-level sustainable planning and management paradigms to support global sustainability issues emerged as a focus of international dialog during the United Nations Conference on Environment and Development, the Earth Summit, held in Rio de Janeiro, Brazil. As a result of this 12-day international dialogue on setting an agenda for future action on environmental and developmental issues, two legally-binding multilateral agreements (Convention on Biological Diversity and Framework Convention on Climate Change) as well as three non-binding agreements: the Rio Declaration, the Statement on Forest Principles, and Agenda 21. Chapter 28 of Agenda 21, Local Authorities' Initiatives In Support Of Agenda 21, incorporated into the agreement as a set of objectives and blueprint for action by local authorities in support of global Agenda 21 objectives, and focused

specifically on improving involvement of community-level stakeholders in formulating new strategies for environmentally sound local planning (United Nations 1997).

As a result of heightened global awareness of past failures, many new action programs were initiated to address the need for improved ways to cope with impacts of expanding urban populations. A few include: The Mega-Cities Project, a non-profit non-governmental network of community, academic, government, business and media organizations, that since 1986 has worked in 18 of the largest cities in the world to identify and transfer best practices for urban innovation (The Mega-Cities Project 2005); The Urban Management Program, initiated in 1986 by The United Nations Human Settlements Program (UN-HABITAT) in partnership with the United Nations Development Program (UNDP) and The World Bank, to “strengthen the contribution that cities and towns in developing countries make towards human development, including poverty reduction, improvement of local participatory governance, improvement of environmental conditions and the management of economic growth” (UN-HABITAT); The Earth Summit’s Agenda 21, formulated as a partnership for a “blueprint for action to achieve sustainable development worldwide” (United Nations 1997); and The 100 Cities Project initiated through Arizona State University to use remote sensing technologies to track multiple impacts of humans in high-density human settlements around the world (Arizona State University).

## **C. PARTICIPATORY URBAN PLANNING**

### **C.1. New Development Models Conducive to Local Stakeholder Input**

While many factors will influence cities' futures, it is clear that new approaches to urban planning are called for given projected increases in the size and numbers of increasingly large urban growth centers in both developed and developing countries (Beatley and Manning 1997). According to Beatley and Manning, a "sustainable community is one that looks beyond narrow, conventional solutions to social and environmental problems and addresses them instead from a broad, holistic viewpoint" (Ibid.).

It was recognized that planning approaches had to be rethought to represent new understanding of the needs to achieve sustainable communities. The new version of urban planning is seen moving forward from the old single-issue approaches, such as transportation or affordable housing, to more integrative approaches that better address the ecology-economy-community complex. These approaches will not succeed if they fail to reflect improved understanding of the interrelation between urbanization and conflict that arises as population density increases and local infrastructure and support services become taxed (Worldwatch Institute 2005).

Many US cities have begun to address the need for a local mechanism to identify and agree on how to move into the future in ways that are sustainable. Out of the new



awareness for the need for controlled and sustainable urban development, some innovative approaches have emerged and been put into action across the U.S., including:

- Smart Growth, promoting development that addresses balance of social, economic and environmental aspects of the community, encourages community input into planning, mixed use of land and existing hard infrastructure, compact building design, walkability in communities, multiple options for transportation, and preservation and incorporation of natural areas (ICMA 2006; USEPA 2007);
- New Urbanism, a planning and building approach that encourages a return to the central role of the traditional healthy neighborhood as a model for growing urban environments, and promotes the reduction of dependence on automobiles by promoting public transportation, walking and biking paths (NAHB 2007);
- The Healthy Communities movement, a program which emerged in the 1980s and grew out of the Ottawa Charter for Health Promotion (Wolff 2003) as a new community-based approach to encouraging and supporting individual health, and one driven by, among other things, widespread community ownership and collaborative problem solving (Ibid.);
- Mixed Use Development, a revision of a development pattern used historically, is a type of compact, or small-footprint/denser occupancy development that promotes integrated land use and the combination (or diversification) in close proximity of residential, commercial/retail, entertainment, employment, and civic establishment (Cervero 1996), and that is seen as a balanced and convenient spatial and functional arrangement that improves access for residents, but that

also attracts investment due to diversification of purpose that reduces risk for real estate investors (Childs et al. 1996); and others.

As cities large and small move towards recognition and adaptation of these approaches to the planning for future development, the limitations and failures of earlier top-down and regulatory strategic planning procedures have been recognized. Many cities have begun a dialogue with citizens, local businesses and other stakeholders to gain community input on preferences for development, issues of greater or lesser importance, services that fulfill community needs or need improvement, and other stakeholder feedback into a planning process (Ellis et al. 1992; National Civic League 2000; McCann 2001; Robinson 1997; Shipley, et al. 2004). Community-based visioning has emerged as one mechanism popularly used to achieve this.

## **C.2 Community-based Visioning**

The word “visioning” has been used to refer to a variety of procedures and techniques that are used in strategic planning (Shipley 2000). The idea can trace its city planning-related origins back to early 20<sup>th</sup> century emergence of new ideas about city building (Ibid., 232), and its philosophical underpinnings concerning the shapability of the future to research and new thinking in the 1950s and 1960s by the Dutch sociologist Fred Polak, Bertrand de Jouvenel working in Paris, and the American Denis Gabor (Ibid.).

Not coincidentally, also in the 1960s, as these new ideas surfaced and prompted new action on the part of leaders at many levels, the concept arose of promoting community action for communities to take care of their own problems, with help from public and private sources of funds and other resources. The first Community Action Program (CAP) in the United States was built on President Lyndon Baines Johnson's "war on poverty" and a related piece of legislation, the Economic Opportunity Act (EOA) (Siriani and Friedland 2001). The EOA mandated community action to reduce poverty, and promoted the emergence of "community action programs" intended to include the maximum involvement possible of residents of the target areas and groups in the development and management of the programs (Ibid.). Participation was a key component of the new CAP approach, and was seen to resonate "with deep American traditions of self-help, local initiative, and Jeffersonian democracy" (Ibid., p. 37). Out of these early programs grew new types of actions like community networking and participatory skills training, and new relationships between local citizen groups and local government and service groups.

Since those early days, the approach has been evolving in more definition from earlier community development approaches. Visioning has become a widely used approach in planning, particularly in the last 20 years. During that time, literally hundreds of visioning exercises have been undertaken in North America, Europe, Africa and Australia as components of larger planning activities (Newman 1993).

While numerous and even contentious definitions, descriptions, and approaches have been offered to characterize and operationalize the essence of "visioning", for the

purposes of this study visioning will be understood to be combination of two convergent definitions: that is, a “long-range planning process which emphasizes shared hopes, purposes, goals, resources, and commitments” (Ellis, et al. 1992, 3) and also “a process by which a community envisions the *future* it wants, and *plans* how to achieve it (Green, et al. 2000).

As implied by this definition, an important aspect of visioning as different from other urban strategic planning approaches is the high rate of participation by the group or community to be affected by the “vision” created during the process. This integrative process is generally characterized by the partnership of citizen groups, planners, local business leaders, elected officials, and other community stakeholders, to assess current conditions, and identify the elements of a desirable future—the Vision—in which are incorporated the priority objectives necessary to achieve the vision. Helling notes that, “visioning usually implies a commitment to collaboration, also called consensus building. In this respect it is fundamentally different from previous planning approaches” (Helling 1998, 336). According to the National Civic League in its community visioning handbook (National Civic League 2000), although it is time consuming, ensuring the participation at the beginning of a consensus-based visioning process of representatives from all sectors in the target community, including individuals, organizations, agencies, businesses and others, will save time at the end of the process when power plays, and lobbying for or blocking options, might otherwise be used as strategies by stakeholders who felt their interests had not been represented during the process. Stakeholder ownership of the resulting plan typically correlates

with the level of stakeholder engagement in the process from the beginning (Ibid.) and, it is hoped, will promote sustainability of the implemented actions.

The rationale for the process of visioning also varies from project to project and between stakeholders involved in the process. For some, it is “a clear and succinct description of what the...community should look like after it...achieves its full potential” (Bryson 1995, 155). Solop notes that “Community visioning is a process whereby a group of people come together to envision the future of a specific entity... and develop an action plan for moving the entity in that direction (Solop 2001, 51). In the case of three municipal visioning activities analyzed and reported by Shipley et al. (2004), visioning project organizers and administrators tended to report in abstract terms the reasons for the visioning activity, such as that citizens are given the opportunity to play larger roles in determining the future of the community, and that “the ‘community vision’ should simply inform decision making, thereby implying that it should be kept squarely in the abstract domain of ideas and guidelines” (Ibid., 205). Citizens, on the other hand, tended to prefer discussing “concrete goals” and physical outcomes” (Ibid.).

In this same study, it emerged during post-visioning project interviews with visioning participants that most felt the greatest testimony to success of a visioning project was that the outcomes of the visioning were being used in decision-making by the local government (Ibid.).

## **D. USE OF SURVEYS IN COMMUNITY-BASED VISIONING**

Surveys are a widely used tool for acquiring citizen and other stakeholder viewpoints. As noted in the Community Visioning and Strategic Planning Handbook, the effective use of surveys has become the focus of an entire industry (National Civic League 2000). While not every visioning process utilizes citizen surveys, very often a scan of residents' awareness of and opinions about issues, services, "assets (those areas/programs in which the community is doing well) and challenges (those areas in which the community is struggling)" (Ibid., 26) is taken via survey instrument to provide important information to add to other data collected from interviews, workshops, local archives, or databases to develop a holistic picture of conditions in the community and directions for the future. As Weisberg, et al. (1996) note, surveys are used to ascertain residents' attitudes, preferences, beliefs, past experiences, and predictions, and to gauge the importance given to something by survey respondents.

Within the context of visioning activities, surveys are developed and administered by varying actors in the process. Some cities interested in learning citizens' opinions about the quality of city services and what citizens expect in the future have used their own staff, sometimes with the assistance of a local university group, to develop and implement targeted surveys which are then mailed to randomly selected residents in the city (District of Saanich 2006) and/or are posted on the city's website (City of San Diego 2004). For larger visioning projects that may be led by city governments, local NGO leaders, groups of community activists or other stakeholder

groups, a survey expert consultant at a university or firm is often hired to develop and administer proprietary (registered and trademarked) (ETC Institute 2006) or custom-designed surveys (Solop 2001) that are commonly mailed to randomly selected households, administered through phone surveys (Ibid.; Blueprint Houston 2003) and may also be distributed through other means.

The surveys used in visioning projects are as varied as the projects themselves. Even in the standardized visioning process outlined in the National Civic League's *Community Visioning and Strategic Planning Handbook* (Okubo 1997) comprising a set of clearly defined steps it suggests all successful visioning activities follow in some form (Ibid., 9), it is noted that "there are many types of surveys, and any number of them may be used depending on the information needed" (Ibid., 20).

Because visioning surveys are designed to measure a variety of variables, the structure of the survey and format of individual questions is tailored to the kind of variables measured and the information sought concerning these variables. Two commonly used survey question formats are open-ended questions and closed-ended questions (Weisberg et al. 1996). Open-ended questions allow respondents to express their own ideas about an issue using their own words, and often produce descriptive text that reveals attitudes and opinions, thought processes, and new ideas about the variable (Ibid.). Responses to these questions are often difficult to analyze and interpret because of the potential breadth and scope of answers provided by the survey participants. Both long and short open-ended text responses may be coded into pre-defined categories, comparing responses among participants, identifying similar and divergent ideas

expressed about the variable, and trying to “read between the lines” to understand or guess what was meant by what was written (Ibid.).

Closed-ended questions may take many forms, all of which are characterized by offering a set of pre-defined response alternatives. Some formats for this type of question that are commonly used in visioning surveys are typically used in collecting demographic data, and include 1) questions offering set ranges, such as age groups, or range of household income; 2) questions requiring selection of one out of a set of pre-defined options, such as ethnicity or highest educational level; 3) questions offering one positive and one negative response, plus a neutral response option; and 4) questions offering rating scales that allow participants to indicate the strength or intensity of their positive or negative viewpoints. Rating scales can be formulated as 5-pointed (having two positive, two negative, and a neutral response option) or 7-pointed (having three positive, three negative, and a neutral response), although in some cases the neutral response option is omitted in order to force participants to take a stance in one direction or the other (Ibid.). A “non-response” option is sometimes offered to allow respondents the option to respond to the question without having to select an option that does not represent the respondent’s actual views. Disadvantages of including non-response options include that they may discourage or intimidate some people from offering a considered opinion, or encourage some to not seriously think about the issue.

Visioning surveys developed by professional survey experts are carefully designed to generate the specific information sought for analysis, worded to avoid ambiguity, bias, double negatives or other (Ibid.), and formatted to incorporate open-



ended and a variety of types of closed-ended questions. However, in spite of the knowledge, guidelines, considerations and checks that inform robust survey design, this researcher has found that almost every visioning survey is structured differently, and from survey to survey, questions are differently formatted and the combination of open-ended and closed-ended questions differs.

Analysis of the data generated by these differently formatted surveys poses another element of confusion. In many cases, the analysts develop a tally of responses given in each response category to create a frequency distribution, and often convert raw response numbers to percentage distributions for each survey question. However, the methodology used by these experts to analyze the data and generate interpretations or conclusions about the survey response data is hidden from public view. Documentation of methodology used is often unavailable, and even if provided, often omits the central procedures used to process the data.

### **D.1 A Sample of Visioning Survey Methodologies**

Through programs funded jointly by the US Environmental Protection Agency, the International City/County Management Association, the Trust for Public Land, public interest organizations, foundations, local and state governments, universities and private firms, literally hundreds of citizen surveys have been funded and implemented in US cities, towns and communities to gauge citizen opinions over the last two decades. To provide a glimpse of the diversity of visioning survey analysis method and resulting

information, the following presents a small sample of city visioning surveys conducted by a variety of organizations and using a variety of survey instruments, delivery approaches, and methodologies for analysis and interpretation.

#### **D.1.a. Sustainable Seattle 2006 Healthy Neighborhoods Survey**

The group Sustainable Seattle's Sustainable Urban Neighborhoods Initiative (SUNI) was initiated as an organized activity to promote communication and collaboration to build healthy and sustainable neighborhoods. Sustainable Seattle implemented this 2006 survey process based on information arising out of an earlier neighborhood dialogue event about people's priorities and ideas for creating stronger neighborhoods as an important component of healthy communities.

Structure of survey: Data was collected exclusively through interviews. Interviewees were identified through a highly subjective "snowball sampling" process based on people recommending other people who they believed met the six characteristics being sought by Sustainable Seattle. One-hour interviews were conducted in neighborhood coffee shops, and were recorded with permission of the interviewees. In addition to a few background questions answered by the interviewees, a 5 block by 5 block matrix of priority themes developed from the earlier neighborhood dialogue event was presented to the interviewees, who were asked to indicate three to five priorities for their neighborhoods. Interviewees were allowed to add personal priorities that did not appear in the matrix. The interviewer then asked a series of questions about why these themes were selected, followed with a longer set of detailed

theme-specific questions, and then completed the interview with final open-ended questions about specific issues Sustainable Seattle deemed important to the goals of the project.

Methodology for analyzing data: No information is provided on how the information collected during the recorded interviews was analyzed and compiled into findings.

Inclusion/exclusion of “neutral” or “no answer” votes: Not applicable.

Statistical reweighing of results to match survey sample demographics to larger population demographics: Not indicated.

Other weighting: Not indicated.

Mapping to a scale: Not indicated

How results were presented: The vast majority of information coming out of this activity was presented as descriptive text with maps, by neighborhood, in the final report. Also presented was a brief comparison of results of this survey with results of the earlier neighborhood dialogue event, and a cumulative analysis of the key issues as they were identified as priorities in the different neighborhoods. A comparison was also drawn between north and south neighborhoods. Information on the frequency of priorities selected by interviewees from different neighborhoods was presented in a table as an annex to the final report. This table served as the basis for pie chart presentations of interview results discussed in the cumulative analysis (Sustainable Seattle 2005).

**D.1.b. San Diego “Which Way Do We Grow?” Survey of 2004**

In an effort to plan for a population expected to grow by 35% from the 2004 level of 1.2 million to an expected 1.7 million within the next 25 years (City of San Diego 2004), and to gain an understanding of how sustainability of the City of San Diego and surrounding region might be fostered, a group of 300 citizens and other stakeholders met in a series of community forums over a three-year period to begin talking about what they believed were the most important environmental, economic, and social characteristics of quality of life for San Diego. Out of this process a set of indicators emerged that allowed identification of specific data that could be used to track the progress in important trends in the city. Some years later when responsibility for the indicator project officially transferred to the City of San Diego, the city added some indicators directly related to the monitoring of issues of specific interest to the city, for a total of 41 indicators grouped into 12 categories: air quality and transportation, housing and neighborhoods, water quality of beaches and bays, crime rate, energy conservation and renewable energy, open space and species protection, water use and reuse, environmental management and climate protection, civic engagement, education system and income, public outreach, and cross-border programs (Ibid.). However, because more public input was deemed critical to the process of planning for sustainability, a survey was designed around the combined set of indicators. City leaders intended to use the survey results to uncover the differences between the facts related to the indicators on the one hand, and people’s perceptions on the other hand, and to use the information uncovered in these interstitial spaces to understand the needs for action to create the

future desired by the city's residents. The city's approach included the caveat that, "First, the indicators do not measure all of the important dimensions of a community. Very often, the things that people want to measure, "happiness" for example, are not included because quantitative indicators are not available. We can only present snapshots of various aspects of the City over a period of time" (Ibid.).

Structure of Survey: Seven main questions and optional questions formed the survey, which was mailed out to 3000 randomly selected residents and also posted online. Of the seven main questions, one identified the zip code of the respondent, three offered a list of several options from which to select (most important reason why respondents live in their neighborhood, how many years respondent has lived in San Diego, and how respondents found out about the survey). The other three questions were posed around the set of indicators, in a format offering Very Positive, Somewhat Positive, Neutral, Somewhat Negative, and Very Negative response options. Specifically, respondents were asked to indicate how important certain aspects of the city were to them, how satisfied they were with these aspects of the city, and how much better or worse these aspects of the city had become in the last five years. Optional questions sought information about age group, ethnicity, gender, household income range, and rentership/ownership of what type of housing.

Methodology for analyzing data: Not indicated.

Inclusion/exclusion of "neutral" or "no answer" votes: Not indicated.

Statistical reweighing of results to match survey sample demographics to larger population demographics: Not indicated.

Other weighting: Not indicated.

Mapping to a scale: Not indicated.

How results were presented: Survey summary results were presented in a table showing, for each of 11 main indicator groups, the major perception of the survey respondents about that indicator (“On the Fence”, “Feeling Good”, or “Needs Improvement”), and one important fact about the indicator. The longer report presents, for each of 11 general indicators, a short discussion of the issues related to the indicator, a summary of survey results indicating percent of votes in one or more response categories (positive, negative and neutral) and how that indicator ranked in importance compared to the others, and sometimes a longer description of what the City of San Diego is doing or proposing to do about the indicator. These write-ups are accompanied by a variety of graphs and pie charts, along with the occasional insert of relevant interesting facts.

#### **D.1.c. National Citizen Surveys™ – Denver, Colorado 2005 Survey**

Since 2001, through a partnership between the International City/County Management Association (ICMA) and the National Research Center, Inc. based in Boulder, Colorado, the National Citizen Survey™ program has used a “uniform survey tool used by widely diverse local jurisdictions across the U.S. to assess resident satisfaction with community amenities and government service provision (National Research Center, Inc. 2006). Through this program, National Citizen Surveys have been administered in over 27 states in the U.S. at the level of city, county, town and village.

In 2005, a customized version of the National Citizen Survey™ was developed and conducted in Denver, Colorado in coordination with staff of the City of Denver.

Structure of Survey: Question format varies, but the National Citizen Survey™ calls attention to and justifies their use of the “EGFP” (Excellent, Good, Fair, Poor) response scale as: one most widely used and understood by elected officials, staff and residents; one that offers the advantage of three positive responses instead of two, offering “finer distinctions among positively rated services” (Ibid.). The National Research Center, Inc. also suggested that an EGFP scale offers the opportunity to have a measurement of absolute quality (e.g., Excellent, Fair) rather than an opinion or satisfaction level (e.g., Strongly Agree, Somewhat Dissatisfied). The survey was mailed to 3000 households.

Methodology for analyzing data: SPSS statistical software package used to calculate frequency distributions and mean ratings.

Inclusion/exclusion of “neutral” or “no answer” votes: The percentages of responses in this category for each question of the survey are presented in data tables, but are removed from the data before analysis, with the exception of “don’t know” responses on two questions that were not evaluative, but were an indication of whether or not there was knowledge of a family member having been victimized by crime with the previous 12 months.

Statistical reweighing of results to match survey sample demographics to larger population demographics: Yes, survey results from 1,017 respondents were weighted to reflect demographics of the City of Denver using two population characteristics whose

sample proportions differed noticeably from the proportions found in the total population, and that had sub-groups with varying opinions (Ibid.). In the case of Denver’s National Citizen Survey, the two characteristics selected were gender/age, and ethnicity.

Other weighting: Not indicated.

Mapping to a scale: Responses from the 4-category format were mapped to a scale of zero to 100, with zero representing the worst possible rating and 100 representing the best possible rating. An average “Good” rating would be mapped at 67, and an average Fair rating would be mapped at 33.

How results were presented: A discussion of each major issue targeted in the survey was presented with accompanying pie charts showing percentage of votes in each “EGFP” category. The mean or average rating was calculated from survey responses for each issue, and presented in a bar chart showing a comparison of this year’s results with the results of two earlier years. Finally, the actual percent voting responses in each response category for each question within each issue were presented in a table that also shows the average response calculated for each question within the issue.

#### **D.1.d. Naperville, IL 2006 DirectionFinder® Survey**

The City of Naperville contracted the ETC Institute, a market research firm (ETC Institute 2007) whose DirectionFinder® survey tool was developed and has been implemented in more than 100 US cities to allow communities to use “statistically valid community survey data as a tool for making better decisions” (Ibid.) as well as to allow



communities to compare themselves to a set of benchmarks established in a database of US cities surveyed using the DirectionFinder® process.

The purpose of the Naperville Illinois survey (ETC Institute 2006) was to understand citizen opinions primarily about city services, and to determine priorities for future action. A total of 2,500 hard copies of the survey were mailed to randomly selected households, and 1,335 surveys were completed either in hard copy, on the phone, or on the Internet.

Structure of Survey: The question format varied. A few questions were formatted as yes/no, some were formatted offering pre-identified multiple choices. The bulk of opinion questions concerning a list of city services, perceptions of a list of safety aspects in the city, and questions asking for citizen levels of satisfaction concerning a list of aspects of the city, were posed offering six categories of response: very satisfied/safe, satisfied/safe, neutral, dissatisfied/unsafe, and very dissatisfied/unsafe, plus a “don’t know” category. A few also offered five categories similar to the six-category questions, with the “neutral” option not offered. Categories were numbered from “5” (or “4” for those not offering “neutral”) as the most positive response, to “1” as the least positive, and the “don’t know” category was indicated as “9”, although these were not weights or values. Following each of the multiple-level approval questions, a follow-up question asked respondents to identify the first, second and third priorities from the previous list. This pairing of the satisfaction responses with an “importance” or prioritizing question for each list provided information used to calculate “Importance-Satisfaction” ratings.

Methodology for analyzing data: For each question, percentages were calculated in every response category by summing all the votes. The percentage of responses in positive categories (response 4 and 5 for 5-option questions) were summed for each question and then subtracted from 1 to give a “satisfaction” indicator. For example, counting votes from all 1,335 respondents, 76% were very satisfied or satisfied with “Maintenance of streets/sidewalks/infrastructure”. In similar fashion, respondents’ indications of first, second and third priorities were calculated to determine an “importance” value for each issue. For this same issue, 40% of respondents indicated that it was one of the most important services. The “Importance-Satisfaction” rating for this issue was then calculated by multiplying the “importance” rating percentage (0.4 in this case) by 1 minus the “satisfaction” percentage (0.76) to give an overall IS rating of 0.0960 for the current status of maintenance of streets, sidewalks and infrastructure.

Inclusion/exclusion of “neutral” or “no answer” votes: “No answer” votes were included in the tabular presentations of the survey data because of the indication given by them concerning knowledge of the city services. However, no description was provided of their inclusion in calculations of the IS ratings. Nor was any description provided for treatment of “neutral” responses.

Statistical reweighing of results to match survey sample demographics to larger population demographics: Not indicated.

Other weighting: Not indicated.

Mapping to a scale: The Importance-Satisfaction scale is mapped from 0.00 to 1.00 in this procedure. A ranking of 1.00 could be achieved if all respondents indicated

an issue was of top priority and none also indicated a positive satisfaction with the issue. A ranking of 0.00 could be achieved if all respondents were satisfied with the issue (thus giving a factor of 1 minus 1 in the equation to calculate the IS), or if no respondents indicated the issue was one of the priority issues (thus giving a “0” for the importance rating portion of the IS calculation. Interpretation of the IS ratings follows the following rules:

If  $IS \geq 0.20$  then Definitely Increase Emphasis on the issue.

If  $0.10 \leq IS < 0.20$  then Increase Current Emphasis on the issue.

If  $IS < 0.10$  then Maintain Current Emphasis on the issue.

How results were presented: The transformed survey data was presented in tabular form, showing issues grouped according to Very High Priority ( $IS \geq 0.20$ ), High Priority ( $0.10 \leq IS < 0.20$ ), and Medium Priority ( $IS < 0.10$ ). For each issue in each group, the overall survey importance percentage is shown, along with the number ranking based on importance of that issue among the other issues in that Survey Question. Also presented for each issue the overall survey satisfaction percentage, and a number ranking based on satisfaction for that issue among the other issues in that Survey Question. The IS rating is shown for each issue, and a final column ranks the issues from first to last based on the IS rating.

#### **D.1.e. Saanich, British Columbia 2006 Citizen Survey**

The purpose of this survey was to identify residents’ opinions about the community and about the associated District as their government and service provider.

Out of 1200 surveys mailed to randomly chosen residents, 382 surveys were completed and returned.

Structure of survey: Questions were presented in various formats, including those offering 5 numbered levels of approval or disapproval ranging on a scale from Very Low/negative (1) to Very High/good (5), plus a No Answer (6) option. Other questions also offered a 1-5 scale of answer options, but each level corresponded to a range of number of times a respondent had used a city facility, participated in a city meeting or visited an arts event during the last 12 months. Response 1 corresponded to “never”, response 2 corresponded to “once or twice”, response 3 corresponded to “three or four times”, response 4 corresponded to “once every 1 to 2 months”, and response 5 corresponded to “more than once a month”. Option 6 corresponded to “not sure”. Several questions offered only “more”, “same”, “less”, or “no opinion” options as responses. Some questions were open-ended and required that survey respondents draft their own answer. One question required that respondents divide a hypothetical budget of \$100 among the most important of 10 options for spending, and to indicate the portion of the \$100 amount they would budget for each of the most important options.

Methodology for analyzing data: For each question, all votes were tallied in each category of response and shown in a statistical table. An average response was calculated as a number out of 100 for each question, and this average was used in the presentation of the survey results in bar charts and other tabular or graphic formats. In many cases the responses were disaggregated by gender, by pre-defined age group, by geographical location (neighborhood), or by status as owner or renter.

Inclusion/exclusion of “neutral” or “no answer” votes: With the exception of three of the questions where the high levels of “not sure/no opinion” responses were kept in the analysis because of their potential meaning, the non-responses were removed from the analyses and the tables and graphs presented in the public reports.

Statistical reweighing of results to match survey sample demographics to larger population demographics: No statistical reweighing was done, but a statement was included in the methodology summary of this survey that results presented in the report are mostly broken down by demographic group, “allowing survey readers to make their own judgements on the differences present” (District of Saanach 2006, 21), and also noted that respondents under the age of 44 and respondents who were renters were underrepresented (Ibid.).

Other weighting: Not identified.

Mapping to a scale: Responses were mapped to a scale from 0, as the lowest or most negative score possible, to 100 as the highest or most positive score possible. Fifty (50) is the neutral point on the scale. “Very good” responses by 100% of the survey takers would be represented as 100 on this scale. If the overall average response to a question came out as “good”, the result would be mapped at 67 on the scale of 0-100, and if the overall average opinion came out as “poor”, the response would be mapped at 33 on the scale (Ibid.).

How results were presented: Varied. Descriptive statements generally present results, often combining “good” and “very good” to give an indication of the positiveness of responses to an issue, and were accompanied by tables presenting the

percentages of votes cast in all response categories, and/or by bar charts showing the average response for the question or for each segment of the question. One question asked respondents to simultaneously rank a list of 58 local public services for satisfaction and importance, and the average results of these votes were presented as points on a quad chart where the x-axis represented the satisfaction scale, and the y-axis represented the importance scale (District of Saanach 2006).

## **D.2. Magazine and Web Survey Methodologies**

In recent years a host of popular magazines and sponsors of Internet websites have led ranking polls to identify “best cities” in which to live, start a business, raise a family, find a job, or retire. As in the case of citizen surveys previously described, none of the pollsters appear to use the same survey format, same data collection process, or same methodology for analyzing and interpreting the data, which often relies heavily on government and other databases, but which may include opinion surveys conducted in the targeted cities. The following section presents analysis of a small sample of these pollsters.

### **D.2.a. CNN.Com/Money Magazine Annual Best City Listing**

For almost 20 years, communities large and small across the US have followed with interest this annual ranking of cities. Most recently, the ranking has focused each year on a different size and category of city for its comparisons. In 2006 the ranking

considered small cities (population 50,000 to 300,000) that combined urban and suburban amenities for a vibrant and appealing quality of life (Money Magazine/CNN.COM 2006). The 2007 ranking targeted American towns with populations from 7,500 to 50,000 (Money Magazine/CNN.COM 2007). The ranking process in 2007 was assisted by the firm OnBoard specializing in data provision, and also called upon the expertise of a consultant from Sperling's Best Places (Ibid.). The rankings are developed using a complex and proprietary process (Guterbock 1997) that differs from year to year due to the changing focus of the ranking, but that generally consists of first selecting communities having population within the target range and eliminating larger or smaller locales. Communities reflecting a pre-defined set of characteristics, such populations where 40% or more are 50 or more years old or more, or communities where 95% or more are Caucasian are screened out, as are communities having high levels of undesirable characteristics such as high crime rates, lack of access to airports or hospitals, sharply increasing unemployment, and other negative aspects or developments. The remaining places are then ranked based on an annually variable list of desirable indicators (Ibid.) comprised of quality-of-life factors such as quality of public schools, arts and leisure opportunities, commute times, park space, and others. Also considered is a set of economic opportunity indicators, examples of which include employment rate, income, affordability, and others. These indicators are not listed in their entirety but only a few examples provided in the description of the methodology posted on the magazine's Internet site. The information for these indicators is derived from review of a long list of databases, some of which are mentioned in the

methodology description and include the U.S. Census and Bureau of Labor Statistics, U.S. Department of Health and Human Services, Department of Energy, National Association of Realtors, U.S. Environmental Protection Agency, to name but a few. As Guterbock pointed out in his assessment of the first ten years of Money Magazine's annual best city rankings, "We know that dozens of indicators are reduced into nine factor scores, presumably by linear combination, but we are not given the actual coefficients" (Ibid, p. 347). The process of assigning weights or importance factors to these many measures of the locale is also not explained.

Community leaders from the places remaining on the "acceptable" list are interviewed once or several times to obtain qualitative and descriptive data about the locales, although it is not clear if a survey is used for these interviews, how the survey is structured, how many people complete the survey, how the survey data is analyzed and interpreted, and how it is combined and integrated with information obtained from the databases to develop the ranking. Additional information about the local ambiance, weather, vitality of the town center, local taxes, and other aspects is sought out through additional research and interviews with leaders and residents. The places moving into the top echelons of the ranking are visited and characteristics of the place documented and confirmed, before the top-ranked place is finally identified.

#### **D.2.b. Inc. Magazine's Top 25 Cities for Doing Business in America**

Historical and current job growth is considered by Inc. Magazine as the best indicator of economic potential of a place for an entrepreneur considering starting a new



business (Kotkin 2004). The annual ranking of the top 25 cities for doing business in America is thus based heavily on information obtained primarily from the U.S. Bureau of Labor Statistics about job expansion or contraction in the locales under scrutiny.

The methodology for constructing the 2004 and 2005 rankings involves calculating a “growth index” and a “balance index”. The growth index is calculated using three separate pieces of information about current and past years’ employment growth rates, normalized and weighted so that: the current and prior year’s employment growth rates (current year’s emphasized) are weighted as two points; the sum of the growth rates for the last two 6-year periods multiplied by the ratio of the earlier 6-year historical period over the most recent 6-year historical period is assigned two points; and the standard deviation of each sector’s growth rate for the last four years is weighted at half a point. The balance index is calculated similarly using normalized weighted summaries of three separate pieces of information concerning employment growth rate among different economic sectors. The final ranking was computed by weighting the growth index by 4.5 out of a total possible 7 points, and weighting the balance index by 2.5 out of the total possible 7 points (Friedman 2004).

For the 2006 ranking, information needed to calculate the “balance index” was not available from the U.S. Bureau of Labor Statistics, so a modification of the “growth index” procedure was used. Instead of three, four specific pieces of information concerning employment growth rate were used to produce a normalized and weighted summary, with point weights assigned differently from the method used in 2004 and 2005 (Inc. Staff 2006).

### **D.2.c. SustainLane 2006 US City Sustainability Ranking**

This website (<http://www.sustainlane.com/us-city-rankings/>) is the showcase for SustainLane, an online company that promotes sustainability over other forms of growth, development, and lifestyle. In 2006 SustainLane ranked 50 U.S. cities for sustainability factors that range from technology to healthy living to services to overall quality of life, with the objective of providing “the most complete report card on urban sustainability” (SustainLane 2007). SustainLane’s methodology for developing the city rankings was based on publicly available data, survey data and interviews for the 50 US cities with the largest populations. Much of the data was collected on a city basis, but some data categories (for example, roadway congestion and metro area sprawl) were only available on a metropolitan area basis. Data or information categories were chosen based on their equal relevance and importance to all 50 cities across the US, and on their ease of access in a standardized format and through publicly available databases. Email and phone surveys were sent out to a target group that included city energy offices, environmental departments, solid waste departments, and others, along with Non-Governmental Organizations working with the cities. Thirty-seven cities responded to the survey, and the other 13 were ranked according to data collected from publicly available sources.

SustainLane adjusted the data (per capita) for green buildings and for local agriculture and food. Of 15 categories of data, 11 were weighted at 1. The other four were each weighted specially: Commute to work was weighted at 1.5 because of the multifaceted direct and indirect impacts vehicles and driving have on the community; traffic congestion was weighted at 0.5 because of the perceived secondary impacts, like

causing lower fuel efficiency due to start and stop driving and idling; affordability was weighted at 0.5 because of secondary impacts high housing prices effect, such as forcing people to move farther away and endure longer commutes to work; and the natural disaster risk factor, also weighted at 0.5. A listing of major categories that were the focus of the cities research was provided.

No explanation was provided of how the rankings were actually calculated, and no explanation provided of survey formats used or how neutral or no-response answers were handled during the data analysis. There was no specification of how the data was adjusted on a per capita basis based on local conditions in the food and agriculture sector.

Comparison of the five city survey procedures and three city ranking processes points to the widely varying designs of the surveys. Question format to obtain a variety of descriptive, explanatory, and quantitative data differs within and among surveys, using open-ended questions as well as closed-ended questions offering multiple response formats. Many surveys posted on the Internet or described in magazines are not accompanied by descriptions of the methodologies used for their analysis. It is noticeable that, not only does there appear to be no standardized format among the many surveys posted on the web and accessible through other media, but that there is no standardized methodology even among the processes whose data analysis methodologies have been provided to the public.

### **D.3. Impact of Survey Results on Action**

In their evaluation of three municipal visioning case studies, Shipley, et al. (2004) made two somewhat conflicting discoveries that may well represent the reality of many visioning projects, and point to a larger issue. On the one hand, “Most interviews revealed that the ultimate indicator of success of the vision was that it was being used by municipal government in major decisions (Ibid., 206). On the other hand, “Over one-third of those surveyed thought that their respective vision statements would have little or very little impact on decision making. Another 40% expected the impact to be moderate” (Ibid., 207). Furthermore, two of the three visioning activities resulted in agreement to create a set of indicators for measuring progress towards the vision, but two years after the project ended, no indicators had been developed and agreed upon (Ibid.).

These outcomes point to the larger issue of a “disconnect” between the results of visioning activities and the actions recommended as a product of the visioning processes. Surveys are used in visioning to assess participant ideas and opinions about present conditions and specifics of a desired future, but the data analysis methodologies used are unclear, information generated is not comparable or combinable, and is of little practical use other than to demonstrate general trends, and not presented in a format that would allow the development and implementation of action plans, which seem to be the visioning outcome most desired by the participants.

A better method for evaluating visioning survey results would be useful.

## **E. EMYCIN TECHNIQUE FOR TRANSFORMING DESCRIPTIVE DATA INTO QUANTITATIVE DATA**

The technique utilized in this study emerged out of early work by computer scientists interested in artificial intelligence, particularly research on the creation of rule-based expert systems.

Expert systems are computer-based systems that rely on information embedded in its programming to assist users in answering questions or solving problems. The quality of the information embedded in the software programming directly impacts the reliability of the information extracted from the system. Thus, the opinions and experience of “experts”, and processes and procedures used in the relevant domains must be acquired and incorporated into the system programming in order for the system to process queries, interpret data available for solutions, and integrate appropriate data to generate solutions (Jones 1984).

### **E.1. Early Work to Develop the EMYCIN Algorithm**

The general program framework for a rule-based expert system includes a database containing facts about the specific problem being addressed, a rule base containing general knowledge about the domain of the problem, and a rule interpreter that conducts the problem solving (Buchanan and Duda 1983). Rules are stated in the form:

**IF** <condition> **THEN** <action>.

The system operates by matching the <condition> to the database, finding the rules that apply, deciding how the rules match the query and the database and, once the match has been found, carrying out the <action> portion of the rule (Ibid.).

Stanford University researchers in the late 1970s developed the MYCIN system, a rule-based expert system, as a tool to help determine the cause of patients' infections and recommend appropriate treatments (Ibid.). This system operated on a set of about 1000 known medical facts, and 450 simple rules, as well as judgmental knowledge of experts in relevant fields of medicine (Ibid.). A set of processes and filters built into the MYCIN system enabled the system to respond to a progression of queries, to identify the likely cause of the infection, and to specify an appropriate treatment. In a double blind evaluation of several test cases of meningitis, the MYCIN system was shown to exhibit expertise on par with that of faculty members' expertise in diagnosing infectious diseases (Yu, et al. 1979).

The EMYCIN system (for "essential MYCIN") (Buchanan and Duda 1983) used in this study was first proposed by van Melle (1980) as the framework for building other non-medical rule-based expert systems. Van Melle proposed that by removing the medical content, one could retain the overall structure and operational procedures of the MYCIN system but fill the system with content apropos to other expert areas.

In the EMYCIN framework, statements of facts and rules are structured as sets of clauses. Each clause is a statement of one fact, composed as an associative triplet of

attribute-object-value, each with an associated degree of certainty, or Certainty Factor (CF), taking the form:

The <**attribute**> of <**object**> is <**value**> with certainty <**CF**>

(Buchanan and Duda 1983).

The verity or confidence of each clause is “weighted” according to the Certainty Factor. Thus clauses and the more complex rules comprised of them, are qualified or weighted according to the level of sureness concerning the facts in the premise of the rule, or the strength of the “value” associated with the rule.

Stated another way, introduction of “rules of thumb” or other experiential or judgmental information into a database also introduces uncertainty that will be associated with the rules formulated from that information. The EMYCIN system addresses the management of certainty and uncertainty for every assertion or rule by associating a certainty measure, noted as “C(A) with every assertion A, where C = +1 if A is known to be true, C = -1 if A is known to be false, and C = 0 if nothing is known about A” (Ibid.). This is shown graphically in fig. 1.

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—	+1.0	Absolutely Positive
—	+0.75	Strongly Positive
—	+0.50	Moderately Positive
—	+0.25	Somewhat Positive
—	<b>0.0</b>	<b>Inconclusive</b>
—	-0.25	Somewhat Negative
—	-0.50	Moderately Negative
—	-0.75	Strongly Negative
—	-1.0	Absolutely Negative

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Figure 1. Scale for Mapping Qualitative Data to a Quantitative Scale of +1/-1

In situations where multiple assertions, or rules, having different certainty levels are considered together, EMYCIN provides a method for combining their evidence. To calculate the certainty level ( C ) resulting from the combination of 2 rules A and B having different certainty levels, the following equations are used:

$$CA + CB - (CA \times CB)$$

where  $CA > 0$ ,  $CB > 0$

$$C \text{ of (Rule A combined with Rule B)} = CA + CB + (CA \times CB)$$

where  $CA < 0$ ,  $CB < 0$

$$\frac{CA + CB}{1 - \min[|CA|, |CB|]}$$

otherwise, where the denominator of the third equation uses 1 – whichever is the smaller



of the 2 absolute values,  $|CA|$  or  $|CB|$ .

This methodology provides a relatively simple way to combine pairs of independent rules or assertions having different certainty factors. The EMYCIN formulas also provide absolute bounds of  $-1$  and  $+1$ , with a defined neutral or “inconclusive” level at zero, such that every paired comparison will produce a new rule or assertion within the  $-1/+1$  bounds. The formulas present an additional advantage in that any number of rule pairs can be combined in any order to determine the certainty level of the combination of the 2 rules (Ibid., 195).

## **E.2. Later Applications of Descriptive-Quantitative Mapping**

Adaptation of this methodology has been limited yet offers great potential. One significant use of the methodology was developed by Dr. Douglas K. Loh, Director of the Laboratory for Systems Technology Applications in Renewable Resources at Texas A&M University. Loh’s work in this area began with testing a methodology to model secondary plant succession using existing GIS computer software and the EMYCIN rule-based structure described above to identify the C (certainty level) associated with a variety of elements and processes of mesquite ecosystems undergoing secondary succession towards expansion of woody clusters (Loh 1995). Soil type and other factors were assigned “favorability ratings” based on the  $+1/-1$  scale described above, according to strength of their influence on expansion of woody clusters. A rule base was developed based on the combination of conditions known to promote this level of

secondary succession, in order to identify spatial parameters (direction and distance) of likely woody cluster expansion (Ibid.).

In a later application of this methodology, Loh, et al. (1998), in collaboration with the USDA Forest Service, developed a toolkit to be used as an interface between forest resource managers and an expert system of forest management rules, with the objective of streamlining the development of rulebases needed as the foundation for a system to support forest management planning and decision making. The toolkit served as an integrator of three different database systems, and thus was required to be compatible with three different types of rules used together to process the set of requirements and values related to the focus of each management decision. In building the rulebases, Loh used the +1/-1 scale as the foundation for identifying the “weight” of each qualitative aspect of a forest resource management decision. For example, conditions affecting susceptibility to soil erosion may include slope of the land, density of underbrush, density of herbaceous ground cover, and others. Using just one of these factors, slope, a rule can be developed to indicate how much erosion will occur depending on the slope of the indicated land. A high percentage of slope, for example greater than 45%, would provide greater potential for soil erosion than would a lower percentage, for example 3%. In building the rule for slope, a slope of 45% or higher would be assigned a weight of -0.75 on the +1/-1 scale, or highly unfavorable to soil maintenance, and highly correlated with increased erosion, whereas a 3% slope may be assigned a weight of -0.1, or only slightly unfavorable to soil maintenance, and correlated with only slight levels of erosion. In this way, each aspect of the major

management rulebases needed to cover all forest management decisions for the district were identified, weighted by experts familiar with the importance of the management options, and built into the management rulebases. Thus the core of the expert management system depends on the database of carefully constructed “**IF** <condition> **THEN** <action>” rules weighted based on the +1/-1 scale.

This study was designed to explore the potential use of this same +1/-1 scale already demonstrated as an effective tool in weighting forest ecosystem management decisions, but applied to qualitative and descriptive data emerging from opinion surveys used during community-based visioning projects.

### **CHAPTER III**

### **METHODOLOGY**

Surveys that generate qualitative and descriptive data are used in both assessments by outsiders of Quality of Life or best characteristics of a place, and in assessments by citizens of preferred development and growth options in their own communities. These surveys rely on a wide variety of methodologies to collect, analyze and interpret raw data to generate “importance” rankings of the survey results. Thus, it is not clear whether results are comparable from survey to survey, or even what results indicate within a single survey.

Very often these results are presented in summary tables, or bar or pie chart summaries, that are easy to understand on a superficial level, but difficult to interpret and from which conclusions cannot be drawn easily if they were to serve as the basis for development planning decisions. For example, table 1 presents partial results of a citizens voting exercise held in 2006 in a city in Texas to obtain input from 500 citizens to prioritize planning for the city’s future.

Table 1. Voting Results for Shaping the City (Centers & Corridors) Building Block (Excerpt) from 2006 Citizens' Congress

Building Block: Shaping the City (Centers & Corridors)			
Statement	Agree	Disagree	Neutral/ Non-response
a. Most future residential, employment, and retail development in the city should occur in mixed use town centers and along corridors in and around the city	81%	11%	8%
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard, or no yard at all.	71%	23%	6%
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store even if it meant having longer commute time to my job.	32%	56%	12%
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	51%	25%	24%*

\* Includes 13% "Neutral" votes and 11% assumed non-responses

What do these results mean? Which statements are the most important to the citizens? What recommendations would one make based on voting results? One could rank the "positiveness" of the statements by arranging them from highest to lowest percent of votes in agreement (a, b, d, c) but this fails to take into account the "disagree" and "neutral" votes. Are the "disagree" and "neutral" votes significant? How would one compare and prioritize voting results between this and information from another Building Block in the same survey? How would one translate the results into a plan of action requiring funds to operationalize in the community? How would one compare the voting results in this community with the results of a similar set of voting results in another community?

The purpose of this study was to address recognized deficiencies in the availability of standard opinion survey analysis techniques by proposing a new technique to evaluate and synthesize descriptive data arising from community preference and opinion surveys. The study analyzed the new application of an existing technique to transform descriptive data from community opinion surveys into weighted quantitative data to derive additional knowledge about the survey results and to enable comparison and integration of different categories of data used for urban planning by leaders of the city's visioning process, city, county and regional planners, and other community stakeholders.

#### **A. DATA COLLECTION**

A nearby city was identified as having initiated in recent years a citywide process to develop a long-range general plan, and as having recently completed a citizen vote on stakeholder preferences and beliefs concerning a set of pre-identified issues grouped as "Building Blocks" for future development in the city. In fact, over a span of more than 5 years, a series of information sharing meetings were planned and held among a wide variety of stakeholders having strong interest in how the city addresses its current challenges and how the city will grow to meet future demands for quality of life for a growing population. Thus, the citizens and other stakeholders had spent several years participating in a visioning process that had produced a set of issues of major shared concern. During this time span, the city's citizens had participated in several surveys

and “votings” designed by visioning process leaders to illuminate for all stakeholders the issues that seemed to be emerging as priorities among the city’s population. The researcher identified 2 differently structured surveys to which the new data transformation technique would be applied: an earlier voter phone survey structured to offer levels of agreement and disagreement as response options, and a later “citizens’ congress” survey offering agree, disagree, and neutral response options.

An initial review of documents was conducted to gain a broad understanding of the visioning process, to understand the level of citizen and other stakeholder participation in the project and to obtain a general impression of stakeholder opinions about growth and development in the city and the surrounding region. The documents reviewed comprised those posted for public access on the Internet by stakeholder groups participating in the ongoing visioning process.

A subsequent set of informal phone and in-person interviews were conducted with some stakeholder institutions’ representatives who had been involved in the visioning and voting processes, to uncover more of the background of the process leading up to the voting. This approach was used to establish a less formal rapport with the organizations’ representatives that would not only permit the researcher to obtain information on the voting procedure and the methodology utilized in analyzing and interpreting the voting results and in developing the set of recommendations that accompanied the report of the voting results, but that also would allow the emergence of opinions about the processes that might lead to revelations about some of the process

details not presented for general public consumption in the official documents posted on the Internet.

The researcher used a set of general questions about the visioning process and the citizen survey and voting processes to promote informal conversation about the background of the visioning project, and the kind and level of stakeholder participation in generating preferences and priorities for planning the city's future. A set of more close-ended questions were then used to establish the role of the interviewee's organization in the visioning process leading up to the citizens' congress, the role of the interviewee's organization in the congress voting and analysis and interpretation of the voting results, and the interviewee's understanding of what processes were used to analyze the survey results and the usefulness of the voting results summary reports.

The researcher also communicated by email with the consultants hired to design and conduct the surveys in both the earlier phone survey project and the later "citizens' congress" activity. Both communications focused on the development, implementation and interpretation of the citizens' congress Building Blocks survey, the voting session, and the methodology used by the firms to analyze and interpret the data collected from the survey.

A review of the phone survey and citizens' congress voting results identified the structure of the 2 surveys and the results generated by survey participants. The summary reports from both surveys were reviewed to understand the methodology used by the evaluators to generate their summary conclusions from the data collected. The researcher then transformed a subset of the voting results into quantitative data using a



data transformation and weighting technique that serves as the foundation for the EMYCIN expert system developed in the early 1980s.

Three aspects of the citizen's congress voting were documented during data collection: 1) the format used in both citizen opinion surveys; 2) the process used by external consultants to evaluate and interpret the results of the surveys; and 3) the summary of results and recommendations for action that emerged from the survey response analyses. Following application of the data transformation procedure, the researcher analyzed the new transformed voting results, addressing aspect 2 for comparison with the initial voting results, and for new information of possible usefulness to stakeholders and planners in developing recommendations (aspect 3) for action plans based on preferences expressed in the voting.

## **B. USE OF EMYCIN TECHNIQUE ON RESULTS OF TWO SURVEYS**

It is known from earlier work that the EMYCIN procedures offer a tool for normalizing disparate qualitative data to a quantitative scale of  $-1$  to  $+1$  that allows data to be compared and combined in analysis. Figure 1 (p. 45) shows the logic of the scale having absolute boundaries at  $+1$  (Absolutely Positive) and  $-1$  (Absolutely Negative).

Zero at the midpoint of the scale presents the neutral or inconclusive point. The portion of the scale between zero and  $+1$  can logically be split at its midpoint to indicate a moderately positive point, just as the portion of the scale between zero and  $-1$  can be split at its midpoint to indicate a moderately negative point. The newly formed segments

can also be split logically at their midpoints to establish the strongly positive/negative and somewhat positive/negative points along the scale.

The objective of using this technique was to determine if its application constitutes a new and transparent methodology that may be widely applicable as a standard technique for evaluating results of opinion surveys commonly used in community and urban planning scenarios, by transforming descriptive survey data into quantitative data that can be mapped on this scale having +1 and -1 as its absolute boundaries, to allow comparison and combination of individual survey responses to produce new information. The technique was applied to a survey of one common format offering Agree/Disagree/Neutral” response options, and to another offering options for different levels of agreement or disagreement (“Strongly Agree” or “Somewhat Disagree”, for example). Many surveys also offer an option for respondents to express neutrality, uncertainty (Not Sure) or unwillingness to answer (No Answer), and sometimes combine the latter two.

A second objective was to identify additional information that may become available from use of this methodology compared to the information available from use of existing methodologies.

The three basic set of steps comprising the application of this technique are: reduction of the range of responses in proportion to the number of non-responses; calculation of a weight or “Index” of the positiveness or negativeness of each statement for mapping and comparison along the +1/-1 scale; and application of the EMYCIN

formulas to combine different statements in a pair-wise combination to determine their combined positiveness or negativeness as mapped on the +1/-1 scale.

### **B.1. Example 1: Citizens' Congress II Voting Results**

The citizens' congress participants voted on a set of statement offering "Agree", "Disagree", and "Neutral" response options. Table 1 shows this format in an excerpt from the survey, for use in detailing the application of this technique.

The first step in the data transformation was to obtain actual numbers of people who cast votes in each category of response by multiplying the total number of respondents (500) by the relevant percentages. Thus, for each response, a new set of numbers was developed as shown in parentheses in table 2:

Table 2. Number of People Having Cast Votes in Each Response Category of "Shaping The City: Centers and Corridors" (Excerpt)

Statement	Agree (No. Agree)	Disagree (No. Disagree)	Neutral (No. Neutral)
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	81% (405)	11% (55)	8% (40)

If mapped along the scale of -1 to +1, the responses for statement "a." above indicates that 405 people's votes would be marked between 0 and +1, although it is not clear exactly where. An additional 55 responses would be mapped between 0 and -1, but again it is not obvious at what point between 0 and -1 these responses would fall.

And what about the influence of the 40 “Neutral” responses to statement “a”? For the purposes of this study, the “Neutral” responses were considered as non-responses, so were treated the same as a non-response. However, because responses to each statement in the survey contained a different number of “Neutral” votes, logic suggests the “Neutral” votes, like non-responses, somehow should be counted into the overall calculation of the weight of each statement.

The next step in the data transformation accomplished this by determining the Range or percentage of total responses for each statement, taking “Neutral” responses into consideration. If all 500 respondents cast a vote with either a positive weight (“Agree”) or negative weight (“Disagree”), this would indicate 100% of respondents cast a vote, or indicated in decimal form, a Range of 1.0. However, each statement included a quantity of “Neutral” responses that may have indicated a number of circumstances, including for example: that respondents considered the statement unimportant; that respondents did not understand the statement; that respondents did not have enough information to render an “Agree” or “Disagree” vote; that respondents had a mixture of positive and negative ideas about the statement that could have been better represented by levels of approval or disapproval (“Somewhat Agree”, “Somewhat Disagree”, for example). Because each question’s responses included some number of “Neutral” votes that have been considered as non-responses for the purposed of this study, and thus having a weight of zero, the Range justifiably may be reduced to include only the actual positive and negative responses. Put another way, recalculating the Range of each question to make it proportional to the number of non-responses allowed the weight of

these neutral or non-responses to be considered in calculating the overall weight of the statement. Logically, this would indicate that the Range of a statement where all responses were either “Agree” or “Disagree” would be 100% (or 1.0 in decimal format) and the Range of a statement having any number of non-responses would be less than 1.

The equation to proportionalize the Range to the number of non-responses is:

$$R = \frac{(\text{Total number of responses} - \text{Number of non - responses})}{\text{Total number of responses}} \quad (1)$$

Applying equation (1) to the data in table 2, the calculated range of the example statement is presented in table 3.

Table 3. Example of EMYCIN Calculated Range

Statement	Agree (No. Agree)	Disagree (No. Disagree)	Neutral (No. Neutral)	Range
a. Most future residential, employment, and retail development in the city should occur in mixed- use town centers and along corridors in and around the city, not just inside the Loop.	81% (405)	11% (55)	8% (40)	0.9200

Assuming that Agree and Disagree responses represent positive and negative responses along a scale from +1 to –1, the next step in the transformation allowed the mapping of each statement onto the +1/-1 scale, its placement on the linear scale determined by number of “Agree” votes and by the number of non-responses as represented in the Range for that statement.

The equation for this step to map each statement at a weighted “Index” point onto the +1/-1 scale is:

$$I_n = \frac{X \text{ Mean}}{\text{Mean} * R} \quad (2)$$

Where:  $I_n$  = the Index of statement N;  
 $X$  = the number of “Agree” or positive responses;  
 $\text{Mean}$  = total number of respondents/2  
 $R$  = the Range for that statement N

Application of equation (2) to the data in the table 3 example, the calculated Index of each statement is presented in table 4.

Table 4. Example of EMYCIN Calculated Index

Statement	Agree (No. Agree)	Disagree (No. Disagree)	Neutral (No. Neutral)	Range	Index
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the loop.	81% (405)	11% (55)	8% (40)	0.9200	0.5704
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	71% (355)	23% (115)	6% (30)	0.9400	0.3948

Each index is a quantitative data point that signifies the weight of the positiveness or negativeness of the statement, and can be mapped onto the +1/-1 scale.

Once the descriptive opinion data, represented as percentages in agreement or disagreement with the statement, are transformed through this process into quantitative data, it is possible to combine the statements to ascertain the cumulative weight of the positive and negative weights of the individual statements. This final step involves the application of the following EMYCIN equations:

$$I_{AB} = I_A + I_B - (I_A \times I_B) \quad (3)$$

Where  $I_A > 0, I_B > 0$

$$I_{AB} = I_A + I_B + (I_A \times I_B) \quad (4)$$

Where  $I_A < 0, I_B < 0$

$$I_{AB} = \frac{I_A + I_B}{1 - \min[|I_A|, |I_B|]} \quad (5)$$

Otherwise

In equation (5), the denominator is calculated by subtracting from 1 the lesser absolute value of the two Index numbers involved.

In the case of the transformed data in table 5, both Index numbers are positive ( $>0$ ) so equation (3) applies in conducting this pair-wise combination of the two statements. Thus in this example, the combined weight Index of statement a. and statement b. is calculated:

$$I_{AB} = I_A + I_B - (I_A \times I_B) \quad (3)$$

$$I_{AB} = 0.5704 + 0.3948 - (0.5704 * 0.3948)$$

$$I_{AB} = 0.7400$$

This new number 0.7400 provides a measure of the composite positiveness or negativeness of the two independent statements when they are combined, and provides a new number that can be mapped to the +1/-1 scale.

## **B.2. Example 2: Phone Survey Results**

Following a series of community meetings, one lead stakeholder organization in the city's visioning process conducted a phone survey of registered voters in the city to obtain their perspectives on a set of questions related to their perceptions of the city's past, present, and future. A significant number of the survey questions permitted participants to respond by selecting from levels of approval or disapproval ("Strongly Agree", "Somewhat Agree", "Somewhat Disagree", "Strongly Disagree", and "Not Sure/No Answer").

Table 5 below presents an excerpt of the phone survey with actual voter responses.



Table 5. Excerpt from Phone Survey with Actual Responses

Q.8. Below is a list of some propositions regarding development and land use policies in the city. For each one please indicate if you are strongly in favor, somewhat in favor, somewhat opposed, or strongly opposed (excerpt).	Strongly Favor*	Somewhat Favor*	Somewhat Oppose*	Strongly Oppose*	Not Sure/ No Answer*
a. More bicycle paths.	.32	.37	.13	.14	.03
b. Stronger restrictions on development in flood plain.	.60	.23	.07	.06	.04

(\* All data shown in decimal percent)

The procedure for transforming qualitative data from surveys structured with levels of agreement and disagreement is similar to that used in transforming the survey used in example 1. The same logic is used to establish a Range, and calculate an Index for each statement or issue, with the difference being an added step to provide weights to each level of positive and negative response.

To transform data from surveys using this format, the first step is to establish the Range by eliminating all non-responses. The second first step is to assign weights to each level of positive or negative response. This will allow strongly positive responses to pull the total weighted Index of the statement towards the +1 end of the scale, and the mildly positive responses to exert a weaker positive pull. Logic suggests that “Strongly Favor” would be assigned a weight of +0.75 and “Somewhat Favor” a weight of +0.25 on the +1/-1 scale.

Table 6 shows the Range for issue a. (more bicycle paths) and b. (tax incentives for locating businesses in depressed areas), and the transformed weighted percentages of responses in issues a. and b. using these logical weights.

Table 6. Range and Weighted Percentages in Each Level of Response (Excerpt from Phone Survey)

Q.8. Below is a list of some propositions regarding development and land use policies in the city. For each one please indicate if you are strongly in favor, somewhat in favor, somewhat opposed, or strongly opposed.	Strongly Favor	Somewhat Favor	Somewhat Oppose	Strongly Oppose	Range
a. More bicycle paths.	0.240	0.093	-0.033	-0.105	0.970
b. Stronger restrictions on development in flood plain.	0.450	0.058	-0.018	-0.045	0.960

In calculating the overall index for each statement or issue, the same pair-wise combination technique used in example 1 to combine weights from different statements is used here to combine weights within the individual statements. Thus one can logically use equation (3) to combine the weights of the “Strongly Favor” and “Somewhat Favor” responses to give a first partial weight Index:

$$I_{AB} = I_A + I_B - (I_A \times I_B) \quad (3)$$

For statement a:  $1^{st} I_{aa} = 0.240 + 0.093 - (0.240 * 0.093)$

$$1^{st} I_{aa} = 0.310$$

For statement b:  $1^{st} I_{bb} = 0.450 + 0.058 - (0.450 * .058)$

$$1^{st} I_{bb} = 0.482$$

Similarly, one can use equation (4) to combine the weights of the “Somewhat Oppose” and “Strongly Oppose” responses to give a second partial index:

$$I_{AB} = I_A + I_B + (I_A \times I_B) \quad (4)$$

For statement a:  $2^{\text{nd}} I_{aa} = (-0.033) + (-0.105) + (-0.033 * -0.105)$

$$2^{\text{nd}} I_{aa} = -0.134$$

For statement b:  $2^{\text{nd}} I_{bb} = (-0.018) + (-0.045) + (-0.018 * -0.045)$

$$2^{\text{nd}} I_{bb} = -0.062$$

To combine the new partial indices for the positive and negative responses, equation (5) is used to accommodate the inclusion of one positive and one negative partial index in the calculation to give a third partial index:

$$I_{AB} = \frac{I_A + I_B}{1 - \min[|I_A|, |I_B|]} \quad (5)$$

For statement a:  $3^{\text{rd}} I_{aa} = (0.310) + (-0.134) / 1 - (0.134)$

$$3^{\text{rd}} I_{aa} = 0.156$$

Statement b:  $3^{\text{rd}} I_{bb} = (0.482) + (-0.062) / 1 - (0.062)$

$$3^{\text{rd}} I_{bb} = 0.416$$

The overall Index of each statement, that is the value of the combined weight of all positive and negative votes, can now be calculated by simply multiplying the product of the third pair-wise comparison by the Range:

For statement a:  $\text{Final } I_A = 0.156 * 0.970 = 0.151$

For statement b:  $\text{Final } I_B = 0.416 * 0.960 = 0.399$

To determine the positiveness or negativeness of a combination of one or more different statements, each having its own Index, this same set of pair-wise combination equations can be used again to calculate a new combination Index “ab” that represents the combination of statement a and statement b. Because both  $I_A$  and  $I_B$  are positive, equation (3) is used:

$$I_{AB} = I_A + I_B - (I_A \times I_B) \quad (3)$$

$$I_{AB} = 0.151 + 0.399 - (0.151 \times 0.399)$$

$$I_{AB} = 0.490$$

These calculation results are presented in table 7.

Table 7: Results Calculated Using EMYCIN Pair-wise Combinations within Statements and Between Statements (Excerpt from Phone Survey)

Q.8. Below is a list of some propositions regarding development and land use policies in the city. For each one please indicate if you are strongly in favor, somewhat in favor, somewhat opposed, or strongly opposed.	1 <sup>st</sup> Pair-wise combination	2 <sup>nd</sup> Pair-wise combination	3 <sup>rd</sup> Pair-wise combination	Index	Combined Index ( $I_{AB}$ )
a. More bicycle paths.	0.310	-0.134	0.156	0.151	
b. Stronger restrictions on development in flood plain.	0.482	-0.062	0.416	0.399	0.490

Complete results and their potential significance are presented in Chapter IV.

## C. ASSUMPTIONS

It is assumed that “Agree” votes indicate positive responses and “Disagree” votes indicate negative responses in a linear relationship along a scale of +1 to -1.

It is assumed that a survey response of “Neutral” and survey response of “Not Sure/No Answer” both contribute zero weight to the calculation of the weight of any survey question’s response, even though the reasons why a respondent would choose a “Neutral” response may differ from the reasons why that same respondent would choose a “Not Sure/No Answer” response.

For the purposes of this study, it is assumed that citizen preference surveys, such as those addressed in this study, are conducted to generate information of usefulness to community and urban planners in the process of planning for growth and development along citizen preference lines within the communities where the surveys are conducted.

It is further assumed that the survey results will be used to guide the community’s political, business, neighborhood and other leaders in planning, finding funds for, and implementing activities as part of the process of growth and development in the communities where the surveys are conducted.

## **CHAPTER IV**

### **RESULTS AND DISCUSSION**

In the following sections, the original results and transformed results of two opinion surveys are presented and discussed, separately. The reasoning behind the use of two surveys was to demonstrate the potential benefit of the application of the EMYCIN data transformation process on results of surveys having a variety of formats, and to identify possible constraints in using this technique to analyze results from several survey formats.

The presentation and discussion of each survey is divided into two sections. In the first section, the original survey results and original interpretations are presented and analyzed. In the second section, the original data is transformed using the EMYCIN technique, and new data presented and analyzed.

#### **A. CITIZENS' CONGRESS VOTING ON BUILDING BLOCKS FOR A VISION OF THE CITY'S FUTURE (2006)**

The second of two citizens' congresses was held in 2006 as part of an ongoing and multi-faceted visioning process in this city, to obtain opinions from participants about a set of urban development issues that emerged from earlier activities in the visioning process. These urban development issues were grouped together into a set of "Building Blocks" that include Floodplains and Parks, Neighborhoods, Shaping the City

(Centers and Corridors) and Transportation. The congress participants divided up into groups of 10 to discuss the pros and cons of multiple growth scenarios identified in discussions and captured in maps during earlier visioning activities, as possible options for achieving longer-term quality of life in the city. Information concerning the issues within each of the “Building Blocks” was provided on fact sheets to the 500 participants to facilitate informed discussion.

Each Building Block section in the survey contained 3-6 statements about which participants were to indicate their opinions. In all cases except one of the transportation statements and one of the wrap-up statements, the response options offered to respondents were Agree, Disagree, and Neutral. This responses format lent itself easily to the application of the EMYCIN data transformation technique. The one transportation statement and one wrap-up statement were omitted from the data transformation process in this study because they require respondents to choose between a set of pre-defined options posing specific conditions as the only possible responses. These choices do not suggest a positive or negative response, thus could not be mapped on a +1/-1 scale, but instead suggest which mix of positive and negative living conditions the respondents would be willing to accept.

External consultants helped lead the congress, developed and administered the voting, and analyzed and interpreted the voting results.

The response percentages for each statement should add to 100%, assuming all 500 voters responded to every question using one of the response categories. It appears that rounding of partial percentages resulted in some statements having a 99% response,

others 101%, and in one case, 102%. Also, one statement came out at only 89%. For the purposes of this study, the adjustment to 100% was made by increasing or decreasing the votes in the Neutral category so that total votes for the statement added up to 100%.

### A.1. Presentation and Summary Analysis of Original Voting Results

The survey statements and a tally of voter responses appear below in table 8.

Table 8. Citizens' Congress Voting Results

Building Block 1: Floodplains and Parks			
	Agree	Disagree	Neutral
a. There should be no further development in the 100-year floodplain even though it will reduce the amount of land for development.	64%	31%	5%
b. Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the floodplain, even if it means higher density development in those areas.	87%	11%	2%
c. The city should spend more money to reclaim land from the floodplain by improving street drainage and developing more retention ponds.	84%	11%	5%
d. Expansion of the park system is important to the quality of life in the city.	96%	3%	1%
e. Given the current city budget constraints, plans to develop linear parks should be accelerated, even if it means building fewer neighborhood parks.	54%	29%	17%
f. New city revenues should be identified to purchase vacant land to build neighborhood parks.	80%	11%	9%
Building Block 2: Neighborhoods			
	Agree	Disagree	Neutral
a. Increased density in existing neighborhoods should be discouraged by steering new development to other parts of the city.	29%	60%	11%
b. A single family house and large yard are so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.	28%	65%	7%
c. I'm willing to have a mixed use center adjacent to my neighborhood if I was assured that the new development is compatible with the character of my neighborhood and does not overload the current infrastructure.	89%	9%	2%



Table 8 (continued). Citizens' Congress Voting Results

Building Block 3: Shaping the City (Centers and Corridors)	Agree	Disagree	Neutral
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	81%	11%	8%
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	71%	23%	6%
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store, even if it meant having longer commute time to my job.	32%	56%	12%
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	51%	25%	24%
Building Block 4: Transportation	Agree	Disagree	Neutral
a. More funds should be directed to forms of travel other than roads, including transit, bikes, and walking.	83%	14%	3%
b. I support increasing our transit choices even if it requires incentives to develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.	86%	9%	5%
c. I am willing to pay a toll for a faster, more reliable trip to my destination.	51%	38%	11%

It can be seen from the voting results presented in Table 8 that the citizens' congress participants cast divergent opinions about the future growth options in the city. Assuming that planning for development in the city would look to these citizen opinions for direction, the task becomes interpreting the voting results to understand what people want and don't want.

**Building Block 1:** Within Building Block 1: Floodplains and Parks, three questions concerned flood plains and three concerned parks. The first three statements (a., b., and c.) within this Building Block concerned development in the flood plains and how to deal with the risks posed by these flood plains – topics of high interest and

political import in this city where long-term and accelerating land subsidence already presents increasingly challenging urban population growth problems. The largest percent of Agree votes (87%) were cast in favor of the statement that flood risks should be minimized by developing stronger building standards for building in the flood plains, or by simply locating new development outside the floodplains, even if more dense development results in those areas. However, a full 84% agreed that the city should spend more money to make development in the floodplains safer by improving drainage and adding more retention ponds. And yet 64% agreed that there should be no further development whatsoever in the 100-year floodplain even though land available for development will be reduced as a result.

Very few neutral votes were cast, and ranged from 3% to 5% of votes. This relatively low number of neutral votes suggests that flood plain issues are important to voters, and tends to suggest that some action rather than no action would be preferable to the voters, although they disagree about what actions should be taken. This disagreement is evidenced by the 11% of “Disagree” votes cast for the statements proposing minimizing flood risks by creating better building standards and proposing that the city spend more money to reclaim land from the flood plain to make it suitable for development, and on the other hand, the 31% of voters who disagreed with the statement proposing cessation of all development in the 100-year flood plain.

The consultants’ interpretation of voting results for these three statements summarized that development in the flood plain should be limited (but not prohibited), especially along some waterway corridors.

It is not clear what methodology was used to derive this conclusion from the voting results, or how the methodology took into consideration all of the responses. For example, 14% of the voters either Disagreed or were Neutral concerning minimizing flood risks by enacting new controls on building so that development could continue in the flood plains, and 16% Disagreed or were Neutral about expanding flood plain land for building by increasing drainage structures and retention ponds. The conclusion was drawn that development should continue in the floodplains, even though 64% of respondents voted that no development whatsoever should occur within the 100-year flood plain. One might wonder how strong the vote is of 64% agreement with the elimination of all building in the 100-year flood plain. Although the responses to the parks questions seemed to indicate that a little more than half of the voters supported building linear parks along the bayous, it is not clear how this information was incorporated into the conclusion drawn concerning future development in the flood plains, or how significant this level of agreement is.

Results of the voting on the three parks questions (d., e. and f.) indicated that 96% of the congress participants Agreed that expansion of the parks system in the city is important to overall quality of life (only 3% of voters Disagreed, and only 1% voted Neutral). However, only 80% Agreed that new city revenues should be identified to purchase vacant land to build new parks (11% Disagreed and another 11% were Neutral). Only 54% Agreed that plans to develop linear parks should be accelerated under current budget constraints, even though it may mean fewer neighborhood parks developed. On this issue of linear parks, 29% Disagreed and 17% were Neutral.

The outside consultants developed the single parks-related conclusion that: “Parks are important to our quality of life and deserve new revenue resources”. It is not clear what rubric the consultants used to combine the opinions and weights of all the votes expressed into one generalized affirmation of what the voters support. It is unclear how the “Disagree” and “Neutral” votes were counted, if at all, in the development of the conclusion. If not counted, these votes represent a potentially significant set of lost information. Apart from the one statement receiving a 96% positive response about parks adding to quality of life, indicating its importance to the voters, the overall positive or negative weight of the response for any other of the statements is not obvious. If the purpose of conducting such a vote were to provide planners with concrete recommendations on action plans based on citizen preferences, the vague summary conclusions provide little guidance on how the issues and options were, or could be, compared or prioritized for later funding and implementation, or how they might be combined to maximize benefit and minimize costs, or achieve other objectives.

**Building Block 2:** As in the case of the interpretation of the Floodplains and Parks voting results, the consultant drew similarly generalized summary conclusions from the results of voting in the other three Building Blocks. For example, Building Block 2: “Neighborhoods” offered three statements for voter reaction. The first two related to increasing population density in existing neighborhoods versus building in new areas to accommodate population growth (statement a.), and the importance of single-family housing with yards for everyone and the accompanying issue of

increasingly long driving distances into the city that would result from the continued outward sprawl if the single-family-home-with-yard formula were everyone's preference (statement b.). These statements were phrased in a way that the proposed scenarios were contrary to the higher-density growth patterns being urged by planners, such that Disagree votes actually counted positively towards new urban planning techniques promoting controlled growth. The Disagree vote levels were 60% and 65% for statements a. and b., respectively, actually indicating that these 60% and 65% of the voters were in favor of more alternatives to the current sprawl-producing growth patterns. The Agree votes indicated acceptance of current sprawl-producing growth patterns, so in effect would be considered as negative towards improved alternatives in growth management. What is noticeable is that over a quarter of the voters approved these scenarios (29% and 28% for statements a. and b., respectively), and an additional approximately 10% were Neutral. The third statement concerned the importance of maintaining the character, look and functionality of infrastructure of existing neighborhoods versus expanding multi-use centers (building centers offering residential, business, retail, and other kinds of occupancy) in the neighborhoods. Agree votes indicated preference for maintaining current neighborhood characteristics, and came in at 89%, with only 9% Disagreeing, and only 2% Neutral. The consultants concluded that: "Higher density neighborhoods are desirable under certain circumstances", a vague summary of the more detailed issues raised in these questions, and derived in an unclear manner from the votes cast.

**Building Block 3:** Building Block 3 statements related to “Shaping the City (Centers and Corridors) addressed options for growth pattern alternatives to the existing mega-center with extended suburban sprawl. Voter responses to statements in this Building Block varied widely, with Agree votes ranging from 32% to 81%, Disagree votes ranging from 11% to 56%, and Neutral votes ranging from 7% to 24%. While the consultants’ conclusion drawn from voting results in this Building Block, “Guiding growth to mixed use higher density town centers is beneficial”, may generally represent voter opinions on these issues, the conclusion is so vague that it fails to give any indication of the variety of opinions or to break down and analyze the differences in opinion to provide a template to guide action planning. It is not clear from the conclusion how the voting responses were analyzed or interpreted, of what the overall weights of the Agree and Disagree votes were for each of the four statements, or what the significance was of the Neutral votes. Because respondents expressed such a diversity of opinions, one conclusion could be that there is no strong consensus, and therefore a compromise or combined solution might be desirable. However, it is not clear how one might combine the scenarios to achieve such a compromise.

**Building Block 4:** The three Building Block 4: “Transportation” statements included in this study addressed voters’ opinions on: increasing funds to develop throughways for bicycles, walking and transit (statement a.); increasing new transportation options even if new housing, employment, and retail incentives would be needed to encourage high usership of these new options (statement b.); and willingness to pay for faster and more reliable transit to jobs and other places (statement c.). Not

surprisingly, level of Agreement with the first two statements was similar and high at 83% and 86% for statements a. and b., respectively. Perhaps also not surprisingly, Agreement with statement c. on willingness to pay for faster and more reliable transit was lower, barely more than half the voters at 51%. Disagreement with statements a. and b. came in at 14% and 9%, respectively, but Disagreement with statement c. was over a third of the voters, at 38%. Neutral votes were cast at 3%, 5% and 11% for statements a., b., and c., respectively. The consultants' conclusion for this Building Block summarized that: "More resources should be allocated to rapid transit." It is not clear why only rapid transit was singled out for increased resources, while walking and bike paths were not included in this summary. Also not mentioned in the summary was the level of approval expressed by citizens for the increased incentives to ensure that usership for the new transportation systems remains high. The conclusion proposes new resources to be made available, but since voters indicated a lukewarm response to paying for these improvements, it is not clear where resources would come from.

The citizens' congress voting results present a significant amount of information about voter preferences in this city, though the interpretation of responses and derivation of a summary conclusion for each of the Building Blocks involved a methodology that is not clear to an external observer. One might assume that the tallying of all the responses provided a summary picture of voter preference trends that the consultants somehow interpreted based on their own training, experience, and understanding of the context in which the survey was conducted. However, it is not clear that the analysis took all Agree votes into consideration in developing the summary conclusions. Each summary

conclusion presented by the consultant appears to be generally related to the set of statements within one or another of the Building Blocks. However, the conclusions are structured to be broad in nature and do not obviously address or interpret the Agree, Disagree, and Neutral votes cast for specific scenarios represented within the Building Block. If a sister community were to attempt to duplicate the voting exercise using the same set of Building Blocks and statements in a citizen opinions survey, there appears to be no mechanism for duplicating the analysis and interpretation.

It is not stated that the consultants evaluating the raw voting results identified a ranking or comparison of statements within the Building Blocks, nor was such a ranking or comparison provided. One might consider that a methodology used to conduct the analysis and interpretation would have to incorporate this step to allow development of conclusions. The survey analysis clearly does not provide a technique for combining statements within or across Building Blocks, to explore options for building action plans and budgets.

To determine if the methodology was more transparent than it seemed to be, the researcher contacted the consultants. The information received from the consultants revealed that the turnout for the citizens' congress had been deemed so positive that the consultants decided to propose conclusions designed with the specific objective of encouraging continuation of the positive momentum in the process of identifying a vision for the city.

Thus, the methodology utilized for this survey constitutes a "black box" process, or unexplainable component, in the analysis and interpretation of this data set from a



citizen opinion survey. One assumes the consultants have developed experience and expertise in the skills for which they are hired, so the level of client confidence would be high, and their analyses assumed accurate. However, use of a “black box” analytical process calls into question the rigor of the analysis and conclusions. The analysis that relies more heavily on an individual’s training, experience, and understanding of context than on more transparent and standardized data analysis procedures incorporates a high level of subjectivity, becomes difficult to understand or duplicate, and provides questionable value as a basis for action planning.

## **A.2. Results of Transformation of Voting Results Data using EMYCIN**

### **Techniques**

When the EMYCIN descriptive data mapping technique described by Loh et al. (1994) was applied to the Citizens’ Congress II voting results, a new set of data emerged. The transformation process is described below, and the transformed survey results are presented in tabular form at each step in the process.

### **A.2.a. Removing Non-responses: Calculating the Response Range for Each Statement**

The first step in the transformation calculated the Range for each statement, or the percent of all votes actually expressing an opinion, by eliminating what were considered non-responses. Assuming that “Agree” and “Disagree” responses constitute

opinions expressed, and “Neutral” responses expressed no opinion, the Range, R, for each statement can be calculated using equation (1):

$$R = \frac{(\text{Total number of responses} - \text{Number of non - responses})}{\text{Total number of responses}} \quad (1)$$

where “Neutral” responses were considered “non-responses”

The Range provides an indication of the overall importance or comprehensibility of the question to respondents. The higher the Range calculated, the higher the percentage of participants who responded to the question, whether with positive or negative votes. Use of this Range later in the process will ensure that the weight of the “Neutral”, or zero-weight, votes will be factored into the calculation of the total positive or negative weight of the responses for each statement. To calculate the Range, the actual number of “Agree”, “Disagree” and “Neutral” votes for each question was calculated from the percentages provided in the original survey, and assumed that all 500 participants responded to every question. The Range for each statement in each Building Block is presented in table 9.

**Table 9. EMYCIN-transformed Survey Results for Citizens' Congress: Range Calculated**

(Assume 500 respondents for all statements)

Building Block 1: Flood plains and Parks	<u>%Agree</u>	<u>%Disagree</u>	<u>%Neutral</u>	<u>Range</u>
a. No further development in the 100-year floodplain even though it will reduce the amount of land for development.	64%	31%	5%	0.9500
b. Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the floodplain, even if it means higher density development in those areas.	87%	11%	2%	0.9800
c. The city should spend more money to reclaim land from the floodplain by improving street drainage and developing more retention ponds.	84%	11%	5%	0.9500
d. Expansion of the park system is important to the quality of life in the city.	96%	3%	1%	0.9900
e. Given the current city budget constraints, plans to develop linear parks should be accelerated, even if it means building fewer neighborhood parks.	54%	29%	17%	0.8300
f. New city revenues should be identified to purchase vacant land to build neighborhood parks.	80%	11%	9%	0.9100
Building Block 2. Neighborhoods	<u>%Agree</u>	<u>%Disagree</u>	<u>%Neutral</u>	<u>Range</u>
a. . Increased density in existing neighborhoods should be discouraged by steering new development to other parts of the city.	29%	60%	11%	0.8900
b. A single family house and large yard are so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.	28%	65%	7%	0.9300
c. . I'm willing to have a mixed use center adjacent to my neighborhood if I was assured that the new development is compatible with the character of my neighborhood and does not overload the current infrastructure.	89%	9%	2%	0.9800

Table 9 continued. EMYCIN-transformed Survey Results for Citizens' Congress: Range Calculated

Building Block 3: Shaping the City (Centers & Corridors)	<u>%Agree</u>	<u>%Disagree</u>	<u>%Neutral</u>	<u>Range</u>
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	81%	11%	8%	0.9200
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	71%	23%	6%	0.9400
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store, even if it meant having longer commute time to my job.	32%	56%	12%	0.8800
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	51%	25%	24%	0.7600
Building Block 4: Transportation	<u>%Agree</u>	<u>%Disagree</u>	<u>%Neutral</u>	<u>Range</u>
a. More funds should be directed to forms of travel other than roads, including transit, bikes, and walking.	83%	14%	3%	0.9700
b. I support increasing our transit choices even if it requires incentives to develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.	86%	9%	5%	0.9500
c. I am willing to pay a toll for a faster, more reliable trip to my destination	51%	38%	11%	0.8900

Beginning with Building Block 1, where statements a., b., and c. pertain to flood plain risks and new building in flood plains, one may observe that the Range provides a single number indicating the percentage of voters who cast either a positive or negative vote about the flood plain statements. While the Range provides no indication of the positiveness or negativeness of the total voting on the related statement, it effectively “counts in” the effect of the non-responses by eliminating them from subsequent calculations of the weight of positive and negative votes.

It is immediately clear that close to 100% of the voters (0.98) expressed an opinion about flood plain statement b., which proposes that flood risks should either be minimized in the flood plains by enacting stronger building regulations, or building should be prohibited in the flood plains. It can also be seen that the Range for statements a. and c. are identical at 0.95. The interpretation of this data is that voters considered these two statements equally important overall, although we will see later that, since they expressed different opinions about the two statements, the overall weight of the statements will differ noticeably.

With a glance at the Range of the three statements related to parks (d., e., and f.), one quickly observes that almost 100% of the voters (0.99) expressed an opinion about statement d. which affirms that expansion of the parks system is important to citizens' quality of life. The importance of this issue was also evident from the original data. However, information not as clear from the original data is that only 83% of participants responded with an opinion on issue e. related to accelerating development of linear parks at the possible expense of more neighborhood parks. In comparison, 91% expressed an opinion on finding revenues to buy vacant plots to convert into neighborhood parks.

As in Building Block 1, the Range of responses in other Building Blocks provides a quick overview of which issues prompted the strongest responses from voters, regardless of whether the total response is positive or negative. For example, in Building Block 2 related to neighborhoods, the Range calculated for statement a. shows that only 89% of voters expressed an opinion concerning whether or not to discourage increased density in existing neighborhoods by expanding new development to other

areas. Issues b. and c. had higher response rates of 93% and 98%, respectively. The Ranges of responses to Building Block 3 statements concerning city centers and corridors show that the highest percentage of opinions expressed (94%) related to voter willingness to live in a town center with a smaller yard or no yard at all if it meant that distances to employment, shopping and recreation were shorter and could be traveled by walking. On the other hand, within this same Building Block only 76% of respondents expressed an opinion on the issue of whether or not the downtown area should remain the regional center for employment and residential growth. Transportation issues prompted more respondents to express opinions than did the city centers and corridors issues, with a Range of 97% calculated for statement a. related to directing more funds to other forms of travel besides roads, and a Range of 95% on the issue of increasing transit options even if new incentives must be developed to encourage high usership of the new options.

While it is possible to do a calculation to obtain this information from the more traditional presentation of survey voting results as presented in Table 9, the Range, or total percent of actual responses for a single survey question, is infrequently calculated and shown as a single number in the presentation of survey results and interpretations, nor is it frequently discussed in summaries of survey results. This information is lost if traditional opinion survey analysis techniques are used, although it could prove to be important and useful to community service providers for gauging community appreciation of the current status of local services, or to planners, particularly if derived

from a citizen opinion survey designed to provide guidance for identifying priorities for which to plan and budget.

#### **A.2.b. Calculating the Positive or Negative Weight of Each Statement: The Index**

The Index is a single number that identifies the overall positiveness or negativeness of each statement based on total number of respondents, number of positive responses for the statement, and the number of non-responses for the statement as captured in the Range calculation. The Index can be mapped on a scale from +1 to -1, and thus offers an extremely powerful one-number comparison tool for planners interesting in understanding the complexities of citizen opinions.

To calculate an Index for each statement, the researcher used equation 2 as follows:

$$I_n = \frac{X \text{ Mean}}{\text{Mean} * R} \quad (2)$$

where:  $I_n$  = the Index of statement N;  
 $X$  = the number of “Agree” or positive responses;  
 $\text{Mean}$  = total number of respondents/2  
 $R$  = the Range for that statement N

Application of Formula 2 to the citizens’ congress voting results generated the Index numbers shown below in table 10.

**Table 10. Citizens' Congress Voting Results with EMYCIN Transformation: Index Calculated**

(Assume 500 respondents for all statements)			
Building Block 1: Flood plains and Parks	<u>%Agree</u>	<u>Range</u>	<u>Index</u>
a. No further development in the 100-year floodplain even though it will reduce the amount of land for development.	64%	0.9500	0.2947
b. Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the floodplain, even if it means higher density development in those areas.	87%	0.9800	0.7252
c. The city should spend more money to reclaim land from the floodplain by improving street drainage and developing more retention ponds.	84%	0.9500	0.6460
d. Expansion of the park system is important to the quality of life in the city.	96%	0.9900	0.9108
e. Given the current city budget constraints, plans to develop linear parks should be accelerated, even if it means building fewer neighborhood parks.	54%	0.8300	0.0664
f. New city revenues should be identified to purchase vacant land to build neighborhood parks.	80%	0.9100	0.5460
Building Block 2. Neighborhoods	<u>%Agree</u>	<u>Range</u>	<u>Index</u>
a. . Increased density in existing neighborhoods should be discouraged by steering new development to other parts of the city.	29%	0.8900	-0.3738
b. A single family house and large yard are so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.	28%	0.9300	-0.4092
c. I'm willing to have a mixed use center adjacent to my neighborhood if I was assured that the new development is compatible with the character of my neighborhood and does not overload the current infrastructure.	89%	0.9800	0.7644



Table 10 continued

Building Block 3: Shaping the City (Centers & Corridors)	%Agree	Range	Index
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	81%	0.9200	0.5704
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	71%	0.9400	0.3948
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store, even if it meant having longer commute time to my job.	32%	0.8800	-0.3168
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	51%	0.7600	0.0152
Building Block 4: Transportation	%Agree	Range	Index
a. More funds should be directed to forms of travel other than roads, including transit, bikes, and walking.	83%	0.9700	0.6402
b. I support increasing our transit choices even if it requires incentives to develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.	86%	0.9500	0.6840
c. I am willing to pay a toll for a faster, more reliable trip to my destination	51%	0.8900	0.0178

From table 10 it can be seen that the Index, or total positiveness or negativeness, of the Building Block 1 statements differs considerably among statements, but all Index numbers are positive. Among the three statements related to flood plains, the most positive Index of the three was calculated at 0.7252, or almost Very Positive (0.75) on the +1/-1 scale, for the same statement b. that received the highest percentage of Agree votes (87%). This statement proposed strengthening building standards within flood zones or else directing new development away from the flood plains. Also noted was that the original survey results reported an Agreement level of only three points less

(84%) for statement c. related to increased investment in street drainage infrastructure and collection ponds, but the Index for this statement was calculated at 0.6460, surprisingly lower on the +1/-1 than the Index for statement b. This larger difference between what appeared to be very high approval at 83%, and the actual EMYCIN-calculated Index of 0.6460 was the result of both the 3% fewer votes of Agree as well as the 2% more votes of Neutral for statement c. than for statement b. Thus, the 5% “Neutral” votes for statement c. were removed during the calculation of the Range, and had the effect of further lowering the Index for this statement compared to the effect the 2% “Neutral” votes had on lowering the Index of statement b., demonstrating the potential weight of each percentage of “Agree”, “Disagree”, and “Neutral” votes in producing a final combined positive or negative weight for a statement. The 64% Agree responses for statement a. proposing that no further development be allowed in the flood plains translated into an EMYCIN Index of calculated at only 0.2947, taking into consideration the fact that 31% “Disagreed”, and another 5% were “Neutral”. When mapped with the other two flood plain Index numbers on the +1/-1 scale, it can be seen that the positiveness of statement a. is significantly lower than that of statement b. and statement c.

In the case of the parks statements, as was the case using the original percentages of responses, the most strongly positive Index of the three parks statements was 0.9108 calculated for statement d. related to the importance of parks expansion to quality of life in the city. Responses to this statement included 96% of voters casting a vote of “Agree”, with only 3% voting in disagreement and only 1% expressing no opinion. The

next highest percentage of “Agree” votes (80%) was cast for statement f. related to finding new city funds to buy vacant lots to convert into neighborhood parks. While this percentage of Agreement gives the impression of being very highly positive, use of the EMYCIN formula calculated an overall Index for this statement of 0.5460, significantly lower than that of statement d. This surprisingly lower Index takes into consideration the 11% who Disagreed and the 9% who voted “Neutral” (counting as zero on the +1/-1 scale). The least positive Index of 0.0664 was calculated from the responses for statement e. on accelerating development of linear parks as short-range solution to the need for more parks and the related budget constraints. This barely positive response is due to the fact that 29% of respondents disagreed with the statement, and another 17% expressed no opinion, so that only just over half (56%) of respondents expressed a positive opinion.

Figure 2 shows the placement of each of the Building Block I Index numbers on the +1/-1 scale.

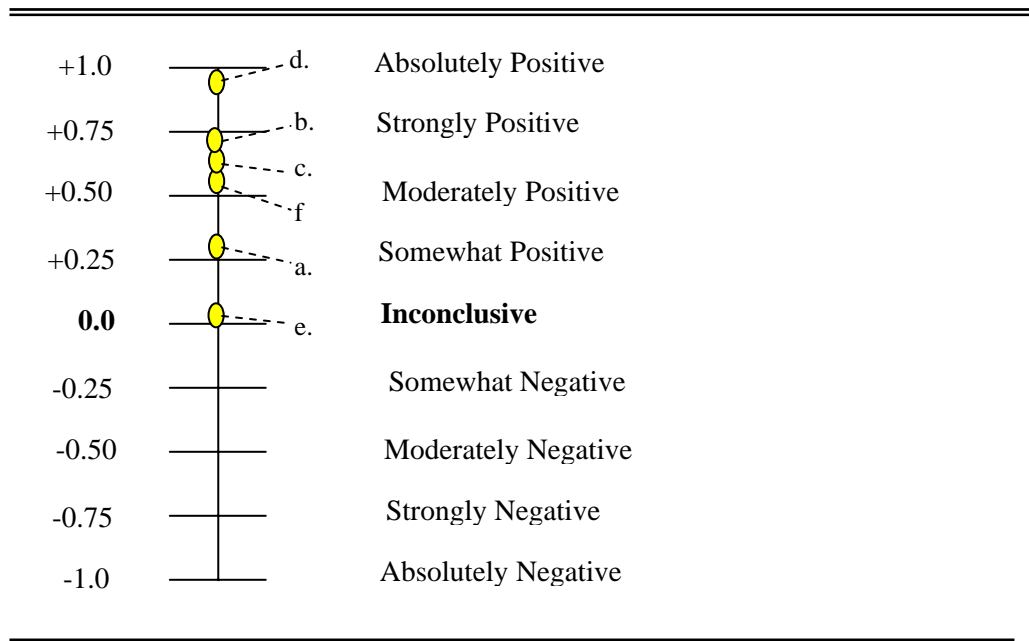


Figure 2. Building Block 1 Statement Responses Mapped on Scale of +1/-1

Although no Index numbers were calculated to be less than zero, use of the +1/-1 scale for mapping offers allows for the integration and plotting of negative (i.e., lower than “Neutral”) opinions in a visually impactful way.

Responses to Building Block 2 statements a. and b. related to continuing the current problematic trends for neighborhood development in the city are slightly more than somewhat negative. Statement a. responses broke down into 29% Agree votes, 60% Disagree votes, and 11% Neutral votes, giving an Index of -0.3738, which is slightly more than somewhat negative according to the logical divisions along the +1/-1 scale. Thus, it can be interpreted that voters are slightly more than somewhat negative towards this proposal for continuation of a non-sustainable growth and development pattern in the city. Statement b. came in still more negative with an Index of -0.4092

due to the fact that only 28% of respondents cast “Agree” votes, 65% cast “Disagree” votes, and 8% cast votes of “Neutral” on this issue of maintaining the single-family-house-with large-yard growth scenario. On the other hand, responses to the new neighborhood development approach proposed in statement c. weighed in at a strongly positive Index of 0.7644, representing 89% of votes having been cast as “Agree” votes, and only 9% having been cast as “Disagree” and 2% having been cast as “Neutral”.

Figure 3 presents the Index numbers for Building Block 2, mapped on the +1/-1 scale.

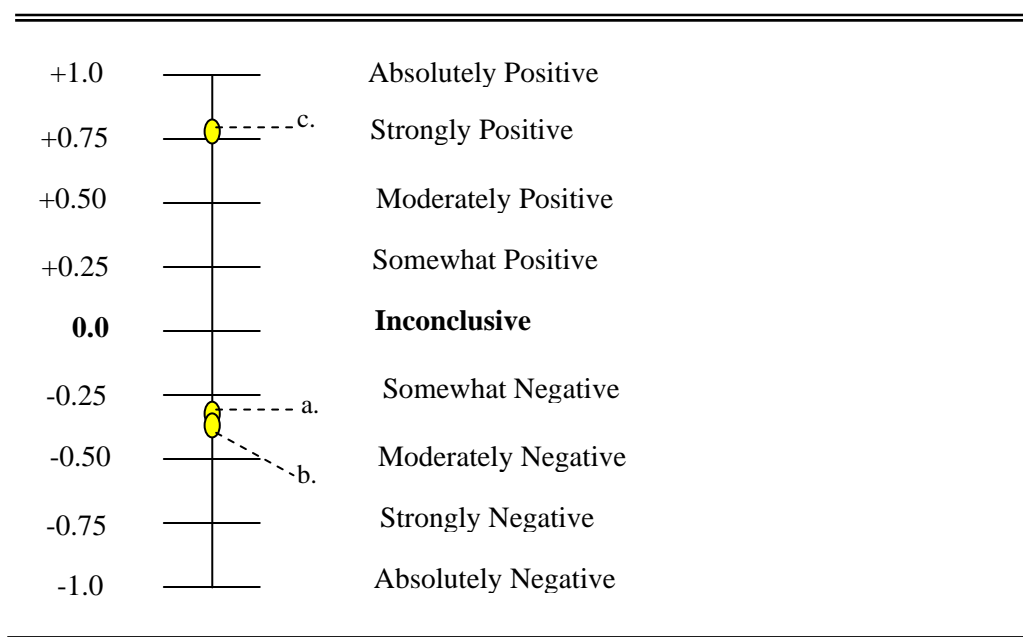


Figure 3. Building Block 2 Statement Responses Mapped on Scale of +1/-1

The Index numbers calculated for Building Block 3 responses show as much variety as did the Ranges for these statements. Statement a. proposing new development in mixed use town centers and along corridors, not just in the current city center, gained

the highest percentage of “Agree” votes at 81%. This sounds very strongly positive until one notes that the Range was only 92% (i.e., 8% of participants cast “Neutral” votes) and another 11% Disagreed. The Index was calculated to be 0.5704, or only slightly more than Moderately Positive on the +1/-1 scale. Statement b. related to willingness to live in a town center where distances were shorter even though yards would also be smaller had a higher Range (0.94) but lower percentage of “Agree” votes (71%). These two elements of the voting response led to the calculation of an Index of 0.3948 on the +1/-1 scale. The Index for statement c. related to living farther out from the city center, near large transport corridors with nearby access to shopping and offering the option of larger yards, but requiring a longer commute to employment, is slightly more than Somewhat Negative at -0.3168. Only 32% of respondents voted in Agreement with this statement, while 56% voted in Disagreement, and another 12% cast “Neutral” votes. A barely positive Index of 0.0152 was calculated for statement d. on continuing to keep the downtown area as the center of all future growth, reflecting the fact that only 51% of respondents voted in Agreement, while 25% disagreed, and another 24% cast “Neutral” votes.

Figure 4 below depicts the ranking of the Index numbers on the +1/-1 scale for the four statements of Building Block 3: “Shaping the City (Centers and Corridors)”.

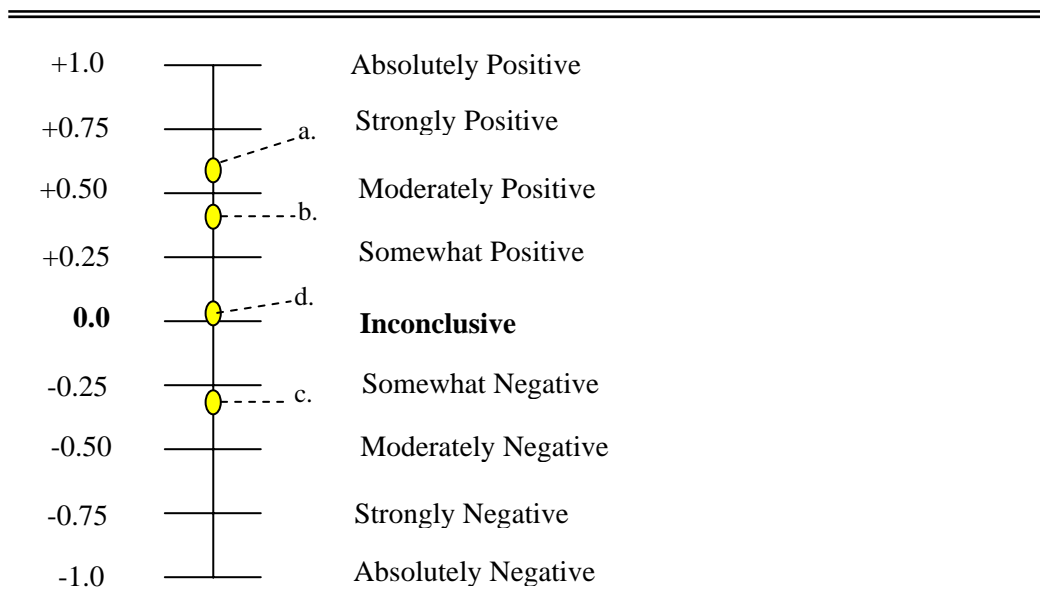


Figure 4. Building Block 3 Statement Responses Mapped on Scale of +1/-1

A similar analysis of Building Block 4: “Transportation” Index numbers shows that statements a. and b. having 83% and 86% positive responses, respectively, generated only moderately positive Index numbers of 0.6402 and 0.6840, respectively. The Index took into account the weights of the 14% Disagree and 3% “Neutral” votes for statement a. (more funds available for other than road travel, including transit, bike paths and sidewalks) and the 9% “Disagree” and 5% “Neutral” votes for statement b. (support for increasing transit choices even if it means new incentives will have to be created to encourage full usership). On the other hand, only 51% of statement c. respondents voted in Agreement, with a significant 38% voting in Disagreement and 10% expressing Neutrality on the issue of willingness to pay a toll for faster and more reliable transportation to destinations. The resulting Index for statement c. was

calculated at the barely positive level of 0.0178. The Index numbers for Building Block 4: “Transportation” statements are shown plotted on the +1/-1 scale in fig. 5.

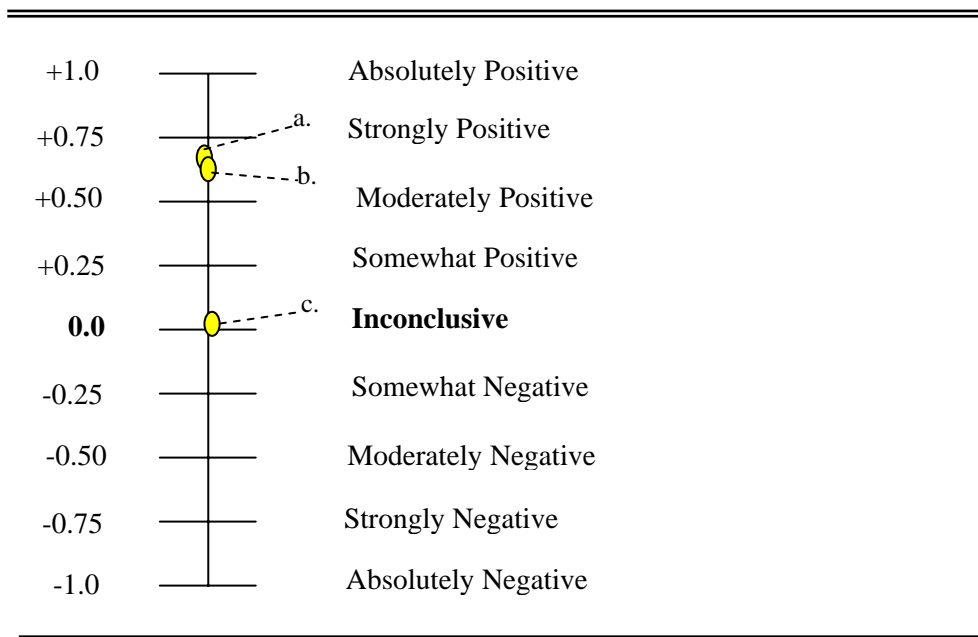


Figure 5. Building Block 4 Statement Responses Mapped on Scale of +1/-1

From this analysis, it can be seen that the Index provides several powerful tools for survey evaluators, city planners, visioning project leaders and other stakeholders. First, one may immediately ascertain the positive or negative weight of each statement with just one number on a scale of +1 to -1 by use of the Index calculation. Stated differently, every aspect of the response to each question is captured in the Index for that question. The non-responses, in this case represented by the “Neutral” responses, are incorporated into the overall weight of the statement by removing them during the calculation to render the Range proportional to the non-responses. The effect of the



removal of the non-responses comes into play during the calculation of the Index, where the Range for each statement, multiplied by the mean number of responses, forms the denominator of the calculation. The effect from the number of positive and negative responses is incorporated through the calculation of the Index where the number of “yes” responses in the numerator controls the overall positiveness or negativeness of the Index for that statement.

Second, because the Index calculation takes the negative and neutral votes into consideration, it presents a lower positive percentage than the percent of voters casting positive votes, and is a more true representation of the positiveness of a statement or option for planning. This would seem logical, since 50% approval of something would indicate a neutral response: exactly half agree and exactly half disagree and/or did not respond. However, in popular culture, winners of political opinion polls, popularity polls, election voting results, and other surveys are commonly determined by gaining 51% of the votes, or even only the largest portion of the votes, giving the impression that these lower percentages of the total vote can be considered “highly positive”. Thus, this aspect of the Index allows the potential cultural “spin” to be removed from more subjective procedures of analysis and interpretation of opinion survey results. An example of this can be seen with statement a. of Building Block 1: “Flood Plains and Parks”, where 64% Agreed, but because 31% Disagreed, and 5% were Neutral, the Index was calculated to be 0.2947, or only slightly above Somewhat Positive.

The Index offers a third powerful one-number tool for instantaneous comparison and ranking among different responses. This is shown in each of the 4 preceding figures

(fig. 2 – fig. 5), where the actual weight as well as the relative weight of each element of the Building Block is shown as Index points on the +1/-1 scale.

Fourth, the single-number Indices can be easily ranked from most positive to most negative, to instantly show the scale of respondent opinion and the priority given to each issue with a single question, or across a larger set of options. For example, table 11 below shows the ranking of Citizens' Congress voting responses both within Building Blocks, and across the entire survey.

Table 11. Ranking of Responses Using EMYICIN-calculated Index Numbers

Building Block 1: Flood plains and Parks	Ranking within Building Block	Overall Ranking
a. No further development in the 100-year floodplain even though it will reduce the amount of land for development.	5	11
b. Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the floodplain, even if it means higher density development in those areas.	2	3
c. The city should spend more money to reclaim land from the floodplain by improving street drainage and developing more retention ponds.	3	6
d. Expansion of the park system is important to the quality of life in the city.	1	1
e. Given the current city budget constraints, plans to develop linear parks should be accelerated, even if it means building fewer neighborhood parks.	6	5
f. New city revenues should be identified to purchase vacant land to build neighborhood parks.	4	9
Building Block 2. Neighborhoods	Ranking within Building Block	Overall Ranking
a. . Increased density in existing neighborhoods should be discouraged by steering new development to other parts of the city.	2	15
b. A single family house and large yard are so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.	3	16
c. I'm willing to have a mixed use center adjacent to my neighborhood if I was assured that the new development is compatible with the character of my neighborhood and does not overload the current infrastructure.	1	2

Table 11 continued

Building Block 3: Shaping the City (Centers & Corridors)	Ranking within Building Block	Overall Ranking
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	1	8
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	2	10
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store, even if it meant having longer commute time to my job.	4	14
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	3	12
Building Block 4: Transportation	Ranking within Building Block	Overall Ranking
a. More funds should be directed to forms of travel other than roads, including transit, bikes, and walking.	2	7
b. I support increasing our transit choices even if it requires incentives to develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.	1	4
c. I am willing to pay a toll for a faster, more reliable trip to my destination	3	13

The overall ranking of this survey results shows that after expansion of parks as the most important issue for quality of life for residents in this city, the next highest priority issue is found within a different Building Block, and suggests that residents are willing to adapt to new building and growth patterns such as “mixed use town centers” as long as the new approaches do not degrade the character and feeling of existing neighborhoods. The third highest priority relates to the flood plains, and specifies that people prefer to either significantly strengthen the regulations and restrictions associated with building in the flood plains, or else they believe development should be contained in areas outside of the flood plains. The fourth highest priority fell into the Transportation Building Block, attesting to the fact that people living in this city want

increased options for transit through the city, even if residential and business development patterns would need to change to ensure that the new transit options were fully used.

When viewed as a whole picture rather than seeing the issues only as they compare to other issues in the same Building Block, one gains a larger view of the breadth of concern and priority issues on the minds of the citizens. No one Building Block contains the top several priority issues, but rather voters are interested in addressing a variety of the city's issues that are not necessarily related to each other.

#### **A.2.c. Combining Statements Using EMYCIN Techniques**

The third and perhaps the most powerful aspect of the EMYCIN technique is the facility with which two (or more) statements having different Index numbers and even different context can be combined using the EMYCIN formulas to generate a combined "positiveness" for the two statements. The combination technique is pair-wise in that it combines the Index numbers of only two statements or options at a time, and produces a new Index number that represents the combined positive or negative weight of the two different options, and that is mappable on the +1/-1 scale.

To blend two positive Index values, equation (3) is used:

$$I_{AB} = I_A + I_B - (I_A \times I_B) \quad (3)$$

where  $I_A > 0$ ,  $I_B > 0$

Two negative Index values are combined using equation (4):

$$I_{AB} = I_A + I_B + (I_A \times I_B) \quad (4)$$

where  $I_A < 0$ ,  $I_B < 0$

In all other cases, where one of the Index values is positive and one negative, the values are combined using equation (5):

$$I_{AB} = \frac{I_A + I_B}{1 - \min[|I_A|, |I_B|]} \quad (5)$$

where: the denominator is formed by subtracting the smaller of the 2 absolute values from 1.

Figure 6 below depicts the way in which combination of any two Index numbers, no matter their values or context, is additive rather than averaging, and eliminates double-counting any value for the combination. In the case of two positive Index numbers, the total Index is more positive than either of the two individual positive Index numbers. Logically it would follow that given two negative Index numbers, the combined Index number would be more negative than either of the two individual negative Index numbers. In the case where one Index is positive and the other Index is negative, the combination will give an Index that is more positive than the negative Index, depending on how strongly positive the positive Index is.

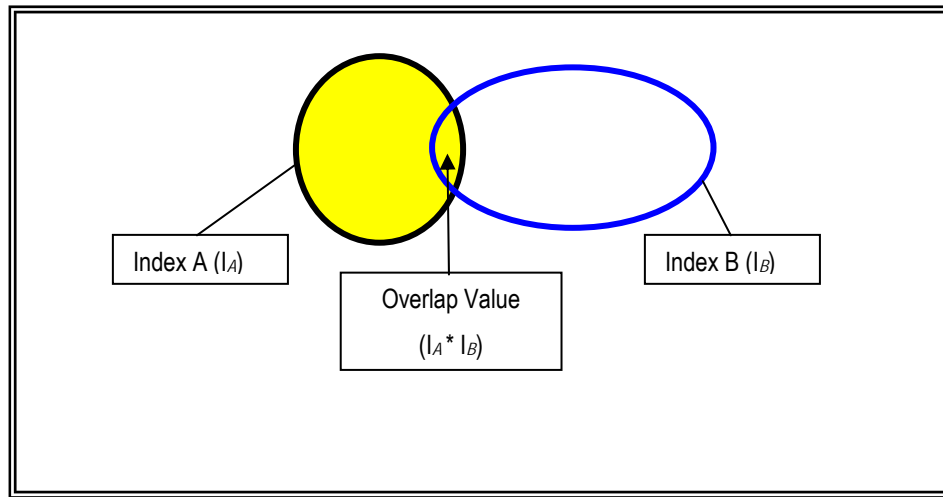


Figure 6. Additive Nature of EMYCIN for Combining Statements

Stated differently, combination of a positive Index and a negative Index will pull the negative Index in a positive direction towards zero or “Inconclusive”, and will tend to pull the positive Index in a negative direction towards zero or “Inconclusive”. As in the case of combining two positive or two negative Index numbers, the distance of the positive or negative displacement along the scale from +1 to –1 when combining a positive and a negative Index will depend on how strongly positive the positive Index is and how strongly negative the negative Index is.

In table 12 below, the Index values within each Building Block are combined in pairs starting with statement a. and combining it with statement b. to derive product “ab”. The next step pairs the product “ab” of these two statements with the Index of statement c. to give product “abc”. This resultant product “abc” is then combined with the Index of statement d., and so on in pair-wise combinations through all of the options.

Table 12. Citizens' Congress Voting Results with EMYCIN Pair-wise Combination

(Assume 500 respondents for all statements)			
Building Block 1: Flood plains and Parks	<u>Index</u>	<u>Pair-wise Combination</u>	<u>Elements Combined</u>
a. No further development in the 100-year floodplain even though it will reduce the amount of land for development.	0.2947		
b. Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the floodplain, even if it means higher density development in those areas.	0.7252	0.8062	(a ** b)
c. The city should spend more money to reclaim land from the floodplain by improving street drainage and developing more retention ponds.	0.6460	0.9314	(ab ** c)
d. Expansion of the park system is important to the quality of life in the city.	0.9108	0.9939	(abc ** d)
e. Given the current city budget constraints, plans to develop linear parks should be accelerated, even if it means building fewer neighborhood parks.	0.0664	0.9943	(abcd ** e)
f. New city revenues should be identified to purchase vacant land to build neighborhood parks.	0.5460	0.9974	(abcde ** f)
Building Block 2. Neighborhoods	<u>Index</u>	<u>Pair-wise Combination</u>	<u>Elements Combined</u>
a. . Increased density in existing neighborhoods should be discouraged by steering new development to other parts of the city.	-0.3738		
b. A single family house and large yard are so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.	-0.4092	-0.6300	(a ** b)
c. I'm willing to have a mixed use center adjacent to my neighborhood if I was assured that the new development is compatible with the character of my neighborhood and does not overload the current infrastructure.	0.7644	-0.4929	(ab ** c)

Table 12 continued

Building Block 3: Shaping the City (Centers & Corridors)	<u>Index</u>	<u>Pair-wise Combination</u>	<u>Elements Combined</u>
a. Most future residential, employment, and retail development in the city should occur in mixed-use town centers and along corridors in and around the city, not just inside the Loop.	0.5704		
b. I would be willing to live in a town center where I could walk or take transit to the store and the park and have a shorter commute, even if it meant living in a home with a smaller yard or no yard at all.	0.3948	0.7400	(a ** b)
c. I would prefer to live adjacent to a transportation corridor where I could have a large yard, walk or take transit to the store, even if it meant having longer commute time to my job.	-0.3168	0.1888	(ab ** c)
d. Downtown should remain the center of the region with the most job growth and increased residential growth.	0.0152	0.2011	(abc ** d)
Building Block 4: Transportation	<u>Index</u>	<u>Pair-wise Combination</u>	<u>Elements Combined</u>
a. More funds should be directed to forms of travel other than roads, including transit, bikes, and walking.	0.6402		
b. I support increasing our transit choices even if it requires incentives to develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.	0.6840	0.8863	(a ** b)
c. I am willing to pay a toll for a faster, more reliable trip to my destination	0.0178	0.8883	(ab ** c)

Because the calculation of the individual statements' Index numbers already has taken into account the neutral responses for each statement, the pair-wise blended Index for each combination presented above in table 11 depicts the total weight of all statements included in the pair-wise combinations up to that point.

**Building Block 1:** Beginning with Building Block I, it is noted that the combination of the Index of statement a. (0.2947) and the Index of statement b. (0.7252) generates a new Index of 0.8062. This new Index represents the combined weight of



both statements, with the negative and neutral responses cast for each statement incorporated into the calculation of the Index for each statement. The Index numbers for both statement a. and statement b. are positive, and their combination using the EMYCIN technique produces a new Index that is more positive than either of the 2 individual statements. Translated into action planning, if statement a. acclaims that, “There should be no further development in the 100-year flood plain even though it will reduce the amount of land for development” and statement b. acclaims that, “Flood risks should be minimized by requiring stronger building standards (such as elevated buildings) or directing development to areas outside the flood plains, even if it means higher density development in those areas”, the combination strategy to achieve an overall approval rate of 80.62% might be to enact new and stronger building standards such as requiring elevated buildings, but also to develop stringent guidelines for limiting or preventing any new development in the flood plains, so that only those developments demonstrating the highest capacity for resisting flooding occurrences and protecting the existing flood plains from further deterioration would be permitted for construction. This might mean that a large percentage of developments proposed for construction in the flood plains would not gain permits and would have to consider locating in other areas with existing higher density. These and other options might be developed into a referendum offered to the voters of the city, or to the stakeholders of the city’s visioning project, for development of a citizen-based priority list of actions related to flood plains development.

Combining the new Index for statement “ab” (0.8062) with the Index for statement c. (0.6460) produces a new combined Index “abc” of 0.9314. Statement c. acclaims, “The city should spend more money to reclaim land from the flood plain by improving street drainage and developing more retention ponds.” Translating this into an action planning context, one interpretation might be that not only should new and stronger regulations and guidelines be enacted to control development in the flood plains, but that for public support of building in the flood plains, the city should also expend infrastructure budget funds on better street drainage and more retention ponds, to expand the safe options for development. Options such as higher development permitting fees then could be identified to narrow development applicants to only those most serious and willing to comply with requirements for preservation of floodplain integrity, and to generate a fund that supplements new infrastructure development funds from the city and county budgets. Possibly many other alternatives could be identified to address the 3 combined issues in a way that maintains public approval at 93.14 %. It should be noted that city managers, community stakeholders, and planners may be interested to know that achieving 93.14% approval of the voters on flood plains issues is even possible.

Consider now the addition of the parks issues. Statement d. acclaiming that, “Expansion of the park system is important to the quality of life in the city” garnered 96% approval from participants in the Citizens’ Congress II. The overall Index for this statement was calculated at 0.9108. If one combined the earlier combined Index “abc” with the highly positive Index for statement d. using EMYCIN techniques, the new

combined Index “abcd” would become 0.9939, or close to 100% approval. Translated into action planning, perhaps in addition to creating new parks in areas where there are none now (80% want the city to come up with new revenues to purchase vacant land and build neighborhood parks on them), an appropriate use of the portions of the flood plains most prone to flooding might be to leave some of the land in parks. Perhaps the more stringent regulations for building in the flood plains might require a percentage of the land to be left in parks. Perhaps the infrastructure expenditures for better drainage and more retention ponds carry with them requirements that new development in these improved areas maintain a percentage of parkland free from development. Other alternative actions could be identified along these lines.

**Building Block 2:** In the case of Building Block 2: Neighborhoods, the first two statements described unfavorable development scenarios related to neighborhoods in the city, and the third statement described a positive development scenario. Predominantly negative responses for the first two negative statements therefore actually indicated a positive response for more appropriate development scenarios, even though these positive scenarios are not described. Only one positive scenario was presented for vote in this Building Block in statement c., for which voters responded 89% in agreement.

Application of the EMYCIN formula to combine the weights of the first two statements (-0.3738 and -0.4092 for statements a. and b., respectively) produced a combined Index of -0.6300. This combined Index compounded the negative Index of statement a. with another negative Index, that of statement b. which had the effect of pushing the combined weight even more towards -1. The new negative weight for “ab”

of  $-0.6300$  reflected moderate disapproval, although in fact the two scenarios presented in statements a. and b. are considered by some sustainable development advocates as inappropriate development alternatives for expanding cities, and thus the  $-0.6300$  would be considered by some as a positive response. Combination of the already-combined Index for “ab” with the strongly positive Index for statement c. of  $0.7644$  reduced the negative weight of the combined Index “ab” from  $-0.6300$  to a more moderately negative  $-0.4929$  for Index “abc”.

Interpretations of this combined Index might have suggested that neighborhood issues are of serious concern to residents of the city, that current patterns of neighborhood growth are undesirable, and that some change in the current neighborhood patterns might be considered acceptable if certain criteria are met. For example, current patterns of single-family-housing with large yard may be abandoned under certain conditions in order to keep sprawl in check. Citizens may be willing to tolerate some increases in density of existing neighborhoods to keep development from continuing to spread in an unplanned way, and this might include willingness to live near a mixed use center if the center were assured to not negatively impact existing neighborhood character and look or the capacity of existing infrastructure.

This situation introduced the issue of the structure of survey questions and its relationship to the extraction of information using EMYCIN techniques. The straight application of the technique as shown in Table 12 above may give a distorted Index—skewed to the negative end of the  $+1/-1$  scale in the case of this Building Block—if the survey questions are designed as in the citizens’ congress II voting, to obtain responses

for analysis and interpretation using traditional response tallies. However, if survey leaders and interpreters had know of the possible use of the EMYCIN technique when designing the survey questions, statement a. might have been formatted alternatively to get the same information by instead declaring, “Increased density in existing neighborhoods should be encouraged rather than steering new development to other parts of the city.” Statement b. could have been alternately formulated to state that “A single family house and yard are not so important to me that I would rather live outside the city where I can have a yard, and find ways to commute to my job.” Assuming the responses would have been the same, 60% would have Agreed with statement a. and 65% with statement b. The Index for statement a. would calculate to 0.1780, given that 29% Disagreed and 11% were still Neutral. The Index for statement b. would calculate to 0.2790, with 28% in disagreement and 7% neutral. Combining these two positive Index numbers using EMYCIN techniques would produce a combined Index “ab” of 0.5067, indicating a moderate agreement with the neighborhood development scenarios proposing increased density and perhaps a shift towards multi-family housing with smaller yards and shorter commutes to work. Combined with statement c., the total Index “abc” for Building Block 2 would then be calculated as 0.6438, a moderately positive response indicating that voters would also accept mixed use centers near their neighborhoods as long as neighborhood character and existing infrastructure is not affected. Although the level of disagreement and neutral responses were somewhat significant, the positive response as indicated by this combined Index “abc” could offer visioning project stakeholders and planners the opportunity to move forward with

identifying a palette of acceptable neighborhood development alternatives to address reduction of sprawl and increased density through mixed use center development.

**Building Block 3:** The combination of statements a. (Index of 0.5704) and statement b. (Index of 0.3948) in Building Block 3: Shaping the City (Centers and Corridors) produced a combined Index “ab” of 0.7400. In this instance, two statements with positive Index numbers were combined to generate an even more positive Index, while taking into consideration all Disagree and Neutral votes expressed for both statements. This strongly positive new Index “ab” can be interpreted to indicate that people will be strongly supportive of enactment of both scenario a. and scenario b. This might be translated as a strongly positive opinion of living in single-family and multi-family housing, even perhaps without a yard, in a future where residential, employment, and retail development in this city occurs in dispersed “town centers” along corridors extending out from the central city, given that transportation infrastructure allows for shorter commutes to work and walking to stores and parks nearby. This knowledge of voter willingness to embrace changes in the shape of the city and its transportation corridors presents visioning project stakeholders and city planners and leaders with powerful information on options possibly available for exploration, with voter approval.

Statement c. proposed a willingness to live near a major transportation corridor offering large yard, and short walk or transit to the store, even if it means a longer commute to work. The Index for this statement was calculated at  $-0.3168$ , taking into account that 56% of respondents Disagreed with part or all of this statement, only 32% responded in Agreement, and 12% remained Neutral. This Index indicated voters were

slightly more than somewhat in Disagreement with the proposed scenario. Combining the Index for statement c. with the already combined Index “ab” of 0.7400 generated a new combined Index “abc” of 0.1888. This significantly less positive combined Index “abc” can perhaps be interpreted to mean that residents would be willing to live farther away from the current center of the city, along transportation corridors where it would be possible to have a single-family home with a large yard, and easy access to stores by walking or short transit time. But if this arrangement means longer commutes to employment in the central city, people are largely not willing to agree to this pattern.

Statement d. proposing the maintenance of the city’s downtown as the center of the region, with most of the job growth and increased residential growth, garnered an Index of 0.0152, barely positive. Combining this Index with Index “abc”, the resulting combined Index “abcd” for all statements in the Building Block was calculated to be 0.2011. The addition of statement d. to the combination of “abc” slightly increased the overall positive weight of the responses in this Building Block. One interpretation of the resulting combined Index “abcd” of 0.2011 might suggest that voters in this city are willing to consider alternative growth patterns, but have significantly differing opinions about how to change and what alternatives might work. Those who feel the traditional city center should be maintained as the center of employment and increased residential growth may be more willing to reside in multi-family housing with smaller yards and short commutes, or even in downtown-based mixed use centers offering retail, employment, restaurant and residential occupancy. However, a significant number of voters would prefer that smaller town centers develop outside of the downtown area,

where single-family housing offering larger yards remains an option, along main transportation corridors, but also offering employment nearby, as well as walking or short transits to stores and parks. This interpretation may offer the most options for coping with the expected population increases in the city over the next 20 years, since a portion of the population may choose to reside in the current downtown area inside the main inner highway loop, and another portion of the population may be more interested in living and working farther out from the center of the city, as long as transportation infrastructure options remain viable and capable of handling the traffic volume. This interpretation is possible because of the power of the combination of Index numbers through the EMYCIN technique, and provides somewhat more detail about acceptable alternatives on which to begin working than does the simple summary made by the consultants that “Guiding growth to mixed use higher density town centers is beneficial.”

**Building Block 4:** Statement a. of this transportation block proposed that more funds be directed to forms of travel other than roads catering to individual vehicles, so that rail transit, bikes and walking pathways are increased. Voters responded 83% in agreement with this proposal, giving an Index of 0.6402. Statement b. gave voters the opportunity to Agree or Disagree with the statement of support for increasing transit choices even if it requires incentives for development of more housing, jobs, and retail along the transit routes, to achieve higher ridership levels. Respondents voted 86% in favor, with only 9% Disagreeing and 5% responding with a Neutral vote. Combining the statement b. Index of 0.6840 with the statement a. Index of 0.6402 produced a combined



strongly positive Index “ab” of 0.8863. Interpretation of this combined Index may suggest that voters are strongly positive about expanding a variety of transportation choices, knowing that funding and efforts will have to be increased to develop these alternatives and new incentives developed and offered to encourage sufficient usership over time of the alternatives to justify their increased costs.

However, the Index for statement c. was calculated at 0.0178, expressing that barely half (51%) of respondents Agreed that they would be willing to pay a toll for use of a faster, more reliable trip to their destinations. Mapped on the +1/-1 scale, this Index would represent a vote of almost “Inconclusive”. However, when combined with Index “ab” of 0.8863, the new combined Index “abc” was calculated at 0.8883, even more strongly positive than Index “ab”, though only a slight increase due to the very slightly positive weight of Index “c”. One might interpret this to mean that although many respondents are supportive of developing new transportation options, they are only slightly more than neutral about paying a toll for a faster or more reliable trip to work or shopping. Expenditures on increasing the number of toll roads may not pay off the way planners might prefer, and might be better spent on other transportation alternatives that will support voters’ interest in having employment, retail and other opportunities in mixed use town centers some distance from the current center of the city.

#### **A.2.d. Combining Unlike Elements**

The power of the EMYCIN combination technique is not limited to combining similar elements. It also provides a powerful tool for comparisons and combination of

unrelated statements or development options. The strength of this tool is based on the conversion of descriptive data such as percent approval and percent strongly in opposition into one-number Indices that can be compared and mapped equally on the +1/-1 scale.

For example, assume the city's budgetary constraints were such that over the next 5 years, funds for development will be limited and only two development proposals will be funded, one related to the flood plain issues, and one related to transportation—two areas of high interest for many of the city's residents. Within this context, suppose stakeholders in the planning process were encouraged to select two development actions, one proposal for addressing flood plains issues and one option addressing transportation, whose combined implementation would generate the highest citizen approval rate.

Assuming that voters who participated in the citizens' congress were representative of the general voter population of the city, the visioning and planning stakeholders identified statement b. of Building Block 1: Flood Plains and Parks, and statement b. of Building Block 4: Transportation as having gathered the highest levels of approval during the congress voting. The results of the congress voting produced an Index of 0.7252 for statement b. of Building Block 1, the highest Index of statements in this Building Block, proposing that flood risks be minimized by either requiring stronger building regulations or eliminating development in the flood plains, even if it meant higher density development in other areas. An Index of 0.6840 was calculated for statement b. of Building Block 4, the highest ranked of the Building Block's statements, which reflects voter support for increasing transit choices even if it requires incentives to

develop more housing, jobs, and retail along the transit routes to achieve higher ridership levels.

By combining these two development options, a new combined Index “bb” was calculated to be 0.9132, signifying a voter approval level significantly more positive than either of the individual statements, as shown in fig. 7.

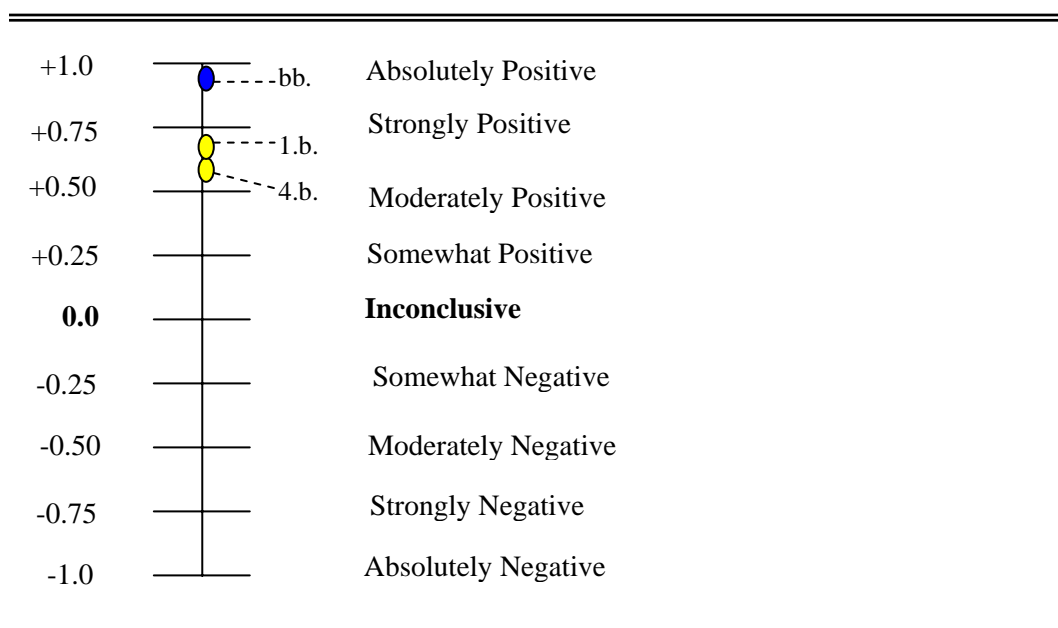


Figure 7. Two Unlike Responses and Their Combined Index Mapped on Scale of +1/-1

Thus, planners and the city council or other implementation group could confirm that the total positive weight of combining these two options was the greatest possible positive weight of any combination of flood plain and transportation statements, taking into consideration all votes, including the negative and neutral votes, expressed for each option. Planning for specific actions to be implemented for these two development

options would be based on voter support and approval, and could be expected to have the blessing of the city budget department.

Through this example it can be seen that development options, services, values and objectives, and other aspects of community planning and visioning evaluated through descriptive surveys, can be dissimilar in nature and easily compared and combined using the EMYCIN technique of transforming descriptive data into single-number weights that can be mapped on the same scale bounded by +1 and -1.

#### **B. PHONE SURVEY OF REGISTERED VOTERS (2003)**

A group of stakeholders in the city's visioning project designed this survey to assist project leaders in identifying the status of voter opinions in late spring 2003, in preparation for the November 2003 general elections and the likely election of new city leaders. The survey was conducted by phone to obtain opinions of a representative cross section of registered voters on topics concerning existing conditions and quality of life in the city, and about a desired future for themselves and the city. The survey was administered and the results summarized by one of the local university professors who has extensive experience in conducting political and citizen polls by phone.

The survey comprises 38 questions or statements. For the purposes of this study, only questions 2-8 are included to demonstrate the application of the EMYCIN technique. Question format varied. Of the questions included in this study, four offer levels of approval and disapproval (Excellent, Good, Fair, Poor or, alternatively,

Strongly Favor, Somewhat Favor, Somewhat Oppose, Strongly Oppose), and levels of concern about the issues (Very Great, Great, Somewhat, Not at All). The other three questions offered positive and negative options as the only options (several also offer neutral options as well): Better, Worse, and Same; and Less Likely, More Likely, and No Difference. All questions offered the Not Sure/No Answer option to cover the variety of situations that would cause the respondent to not answer.

### **B.1. Presentation and Discussion of Original Voting Results and Conclusions**

Table 13 below presents the phone survey questionnaire and the results obtained from 1002 respondents for selected questions. Percent responses in each category are presented in decimal format.

The responses for questions 2, 5, and 8 of table 12 offer rich matrices of information on citizens' opinions. Question 2 asks citizens to critically rate the current status of a set of 12 aspects of the community. Survey respondents are offered the options of "Excellent", "Good", "Fair", "Poor", and "Not Sure/No Answer" for their responses. With the exception of the city's arts and cultural opportunities (question 2c), and the city as a place to live (question 2l), which were ranked as "Excellent" by 25% and 14% of the respondents, respectively, only a few respondents gave excellent ratings to any aspects of the city.

Table 13. 2003 Phone Survey Results

(Number of respondents: 1002)					
	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>NS/NA</u>
Q. 2. How would you rate:					
a) Job opportunities	0.03	0.30	0.40	0.22	0.06
b) Pub school quality	0.03	0.27	0.40	0.21	0.08
c) Arts/culture opportunities	0.25	0.44	0.19	0.06	0.06
d) Air quality	0.01	0.11	0.33	0.54	0.01
e) Pub safety/crime control	0.01	0.28	0.46	0.24	0.02
f) Racial/ethnic relations	0.03	0.37	0.42	0.14	0.04
g) Green space/parks	0.04	0.41	0.37	0.16	0.03
h) Recreation opportunities	0.09	0.48	0.30	0.09	0.04
i) Health care for low income	0.03	0.19	0.28	0.32	0.16
j) Drainage/flood control	0	0.15	0.34	0.48	0.04
k) Mobility in city	0.03	0.23	0.32	0.40	0.02
l) The city as place to live	0.14	0.55	0.25	0.05	0.01
	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>NS/NA</u>	
Q.3. The city in last 10 yrs	0.39	0.28	0.29	0.04	
	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>NS/NA</u>	
Q.4. The city in next 10 yrs	0.43	0.22	0.28	0.06	
	<u>Very great</u>	<u>Great</u>	<u>Somewhat</u>	<u>No Concern</u>	<u>NS/NA</u>
Q.5. How concerned are you about:	<u>Concern</u>	<u>Concern</u>	<u>Concern</u>		
a) Difficult to get around	0.23	0.35	0.27	0.13	0.01
b) Deteriorating neighborhoods	0.16	0.36	0.30	0.14	0.04
c) Too many below poverty line	0.19	0.38	0.24	0.10	0.09
d) Shortage of affordable housing	0.16	0.30	0.23	0.19	0.11
e) Inadequate pub education	0.25	0.36	0.19	0.12	0.09
f) Shortage of public parking	0.23	0.31	0.23	0.19	0.03
g) Loss of open space to development	0.21	0.35	0.21	0.18	0.05
h) Shortage of good public transportation	0.20	0.29	0.23	0.21	0.06
i) Shortage of nearby park space	0.12	0.19	0.24	0.42	0.04
j) Insufficient city/suburb cooperation on problems	0.18	0.30	0.25	0.17	0.11
k) Low neighborhood diversity	0.07	0.19	0.27	0.39	0.09
l) Lack of local vision/planning to deal with problems	0.23	0.39	0.24	0.10	0.05
m) Need more sidewalks	0.26	0.34	0.22	0.14	0.05
	<u>Strongly</u>	<u>Somewhat</u>	<u>Somewhat</u>	<u>Strongly</u>	<u>NS/NA</u>
Q.6. Creation of General Plan	<u>favor</u>	<u>favor</u>	<u>oppose</u>	<u>oppose</u>	
	0.59	0.23	0.06	0.06	0.06
	<u>More Likely</u>	<u>No Difference</u>	<u>Less Likely</u>	<u>NS/NA</u>	
Q.7. Likelihood of voting for candidate offering Strong development guidelines	0.57	0.23	0.1	0.11	

Table 13 continued

	<u>Strongly</u> <u>Favor</u>	<u>Somewhat</u> <u>Favor</u>	<u>Somewhat</u> <u>Oppose</u>	<u>Strongly</u> <u>Oppose</u>	<u>NS/NA</u>
Q.8. Opinion on development proposals:					
a) More bicycle paths	0.32	0.37	0.13	0.14	0.03
b) Stronger restrictions on development in flood Plains	0.60	0.23	0.07	0.06	0.04
c) Business tax incentives for locating in Depressed areas	0.41	0.35	0.10	0.08	0.07
d) Using public funds to restore historic buildings	0.31	0.38	0.15	0.12	0.04
e) Using public funds to improve and add new public parks	0.41	0.39	0.10	0.06	0.03
f) Establish green space/wetlands zones off limits to development	0.48	0.33	0.08	0.06	0.06
g) Adding more express bus service	0.40	0.35	0.11	0.07	0.08
h) Additional rail transit	0.42	0.26	0.11	0.14	0.07
i) Street/highway widening to carry more traffic	0.39	0.30	0.13	0.14	0.04
j) More curbside recycling	0.49	0.33	0.08	0.05	0.06
k) Imposing new regulations to reduce air Pollution	0.61	0.24	0.06	0.06	0.02
l) Expand frequency and routes for bus service	0.44	0.31	0.09	0.07	0.08
m) Stronger land use controls to control urban Sprawl	0.39	0.31	0.10	0.07	0.13
n) Make it easier to walk in city	0.57	0.30	0.04	0.03	0.06

Arts and cultural opportunities again were ranked as “Good” by 44% of respondents, 48% of respondents ranked recreational opportunities (question 2h) as “Good”, and 55% of respondents voted that the city was a “Good” place to live. Also receiving a fairly healthy percent (37%) of “Good” votes was the issue of green space and parks (question 2g). On the downside, only 1% of respondents ranked the city’s air quality (question 2d) as “Excellent”, and 11% ranked it as “Good”. Concerning drainage and flood control (question 2j), nobody ranked the city as “Excellent” and only 15% voted that this aspect of the city was “Good”. Only 3% of the survey respondents rated

the city's health care provisions for low-income residents (question 2i) as "Excellent", and 19% rated it as "Good".

High percentages of "Fair" ratings were voted by the respondents for a number of aspects of the city including public safety and crime control (question 2e) at 46%, job opportunities (question 2a) at 40%, racial and ethnic relations in the city (question 2f) at 42%, and the quality of public schools (question 2b) at 40%. The highest percentages of "Poor" votes were given for air quality (question 2d) at 54%, and drainage and flood control (question 2j) at 48%, but several other aspects of the city also received more than 30% of "Poor" votes, including mobility in the city (question 2k) at 40%, and health care for low-income residents (question 2i) at 32%. The issue receiving the highest number of "Not Sure/No Answer" responses (16%) was that of health care for low-income residents; next highest in "NS/NA" responses was question 2b, with 8% respondents not sure or had no opinion on the issue of public school quality.

The consultant's summary of responses to this question points to the high combination of "Excellent" and "Good" scores given by city's voters to local arts and cultural opportunities (69%), the city as a good place to live (69%), and availability of recreational opportunities (57%). Low scores (exclusively "Poor" responses) were noted for air quality (54%), drainage and flood control (48%), mobility (40%), and access to health care for low-income residents (32%). Responses of "Fair" did not appear to be considered in the consultant's summary report, although more votes were cast in this category than in any other.



Questions 3 and 4 asked voters' opinions about whether the city has become better or worse or stayed the same in the last 10 years (question 3.) and whether voters expect the city to become better or worse or stay the same in the next 10 years (question 4.) Summarizing votes cast on these two questions, the consultant points out that more voters (39%) voted that things have gotten better in the last 10 years than voted that conditions have gotten worse (28%) and, similarly, more respondents (43%) believe the city will improve in the next 10 years than believe the city will become a worse place to live (22%). Other results not mentioned in the consultant's summary are the fact that more people (29%) believed the city had stayed the same over the last 10 years than people who thought living conditions had become worse (28%), and more people believe the city will stay the same in the next 10 years (28%) than people who believe things will get worse (22%). Adding up the percentages in the survey results, more than half the respondents (57%) think the city has either gotten worse or remained the same in the last 10 years, and exactly 50% of the voters believe things will remain the same or deteriorate in the next 10 years—a somewhat less positive picture than that painted in the consultants' summary of results.

Question 5 asked voters to express their level of “concern” about a list of 13 aspects of living in this city. Voters were given the options to identify the issues as “Very Great Concern”, “Great Concern”, “Somewhat a Concern”, “No Concern”, and “Not Sure/No Answer”. Given that these votes reflect expressions of negative feelings about the issues, one would understand that the highest percent of positive responses show the highest level of concern and thus represent the most negative opinions. The

highest percent response (26%) for areas of “Very Great Concern” was expressed concerning the need for more sidewalks for walking in the city (question 5m), and the inadequacy of the public education system in the city (question 5e) at 25%. Three other issues that were each ranked as “Very Great Concerns” by 23% of respondents were the difficulty of getting around in the city (question 5a), the shortage of public parking (question 5f), and the lack of local vision and planning (question 5l). Another 21% of respondents rated the loss of open space to development (question 5g) as a “Very Great Concern”. At the low end of the spectrum of votes, the issue of low neighborhood diversity (question 5k) was identified by only 7% of respondents as a “Very Great Concern”. The shortage of nearby park space (question 5j) was rated as a “Very Great Concern” by 12% of survey participants, and shortage of affordable housing (question 5d) was identified by 18% as a “Very Great Concern”.

Issues that were identified as “Great Concerns” by large percentages of respondents included lack of local vision and planning (question 5l) at 39% of respondents, too many citizens living below the poverty line (question 5c) at 38% of respondents, the inadequacy of the public education system in the city (question 5e) at 36% of respondents, deteriorating neighborhoods (question 5b) also at 36% of respondents, and loss of open space to development (question 5g) and the difficulty of getting around in the city (question 5a), both garnering votes as “Great Concerns” by 35% of respondents. This category was the most selected category by the highest number of respondents.

The category of “Somewhat a Concern” was the next most selected category in question 5. The issues identified in this category by the highest number of respondents were the deterioration of neighborhoods (question 5b) at 30% of respondents, low neighborhood diversity (question 5k) at 27%, difficulty in getting around (question 5a) at 27%, insufficient city/suburban cooperation on problems (question 5j) at 25%, and shortage of nearby park space (question 5i) and too many living below the poverty line (question 5c) at 24% of respondents each. The issue receiving the fewest votes in this category was the inadequacy of the public education system (question 5e), receiving 19% of respondents’ votes.

Other than the 42% of respondents voting that the shortage of nearby park space was of “No Concern” to them, and another 39% indicating that low neighborhood diversity caused them “No Concern”, the percentages of votes appearing in this category are comparatively low, indicating that most issues cause most citizens some concern. And the highest percentage of responses in the “Not Sure/No Answer” category came in relation to the issues of shortage of affordable housing (11%), insufficient city/suburban cooperation on problems (11%), and three issues each receiving 9% of respondents votes in this category: too many citizens living below the poverty line; inadequacy of the public education system; and low neighborhood diversity.

The consultants’ summary of voting on this complex question combines the responses in the “Very Great Concern” and “Great Concern” categories to report that the issues of highest concern facing the city’s residents are lack of vision or planning in dealing with local problems (62%), the inadequacy of the public schools to educate the

city's children (61%), the lack of good sidewalks for walking in the city (60%), and difficulty in getting around the city (58%). This analysis eliminated and in effect threw away a considerable amount of information about the voters' opinions.

Question 6 asked the city's voters how they feel about developing a general plan as a guide for growth and development in the future. Fifty-nine percent of the respondents voted "Strongly in Favor" of creating a general plan for development. Another 23% voted that they "Somewhat Favor" developing a general plan. Eighteen percent of voters either "Somewhat Oppose" a general plan (6%), "Strongly Oppose" it (6%), or are not sure or did not respond (6%). The consultants' summary mentioned only that six out of the survey participants (59%) cast a vote strongly in favor of developing a general plan to guide the city's growth.

Interestingly timed right before a general election, question 7 asked voters if they would be more likely or less likely to vote for political candidates offering strong development guidelines for the city, or would the issue not effect their votes. The consultant's summary points out that 57% of respondents said they would more likely vote for such a candidate. Not mentioned, however, were the 23% who said it would make no difference to their vote, the 10% who responded that they would be less likely to vote for such a candidate, and the 11% who were not sure or did not respond.

Question 8 proposes a list of 14 possible development actions to take for the city's future, and asked participants to indicate whether they would "Strongly Favor", "Somewhat Favor", "Somewhat Oppose", or "Strongly Oppose" these proposed actions, or whether they have no opinion.

The consultants' summary pointed only to the issues for which respondents expressed the strongest approval, including new regulations to reduce air pollution (question 8k) at 61% "Strongly in Favor", restricting development in the flood plains (question 8b) at 60% "Strongly in Favor"), and making it easier to walk in the city (question 8n) at 57% "Strongly in Favor".

Among the things not mentioned was that many other development options presented in question 8 gained high numbers of "Strongly Favor" responses. For example, 49% (almost half) of respondents "Strongly Favored" having increased curbside recycling (question 8j); 48% (also almost half) voted "Strongly in Favor" of making green space and wetlands off limits to development (question 8f). Forty-four percent of respondents voted "Strongly in Favor" of expanding the frequency and routes for bus service in the city (question 8l), and 41% of respondents were "Strongly in Favor" of creating business tax incentives for locating new businesses in depressed areas (question 8c) and using public funds for parks (question 8e). The issue receiving the lowest number of "Strongly Favor" responses was that of use of public funds to restore historic buildings (question 8d), with only 31% of votes.

Also not mentioned by the consultants' report was that many respondents "Somewhat Favored" these issues. For example, 39% were "Somewhat in Favor" of using public funds for parks (question 8e), 38% were "Somewhat in Favor" of using public funds to restore historic buildings (question 8d), and 37% were "Somewhat in Favor" of more bicycle paths in the city. The issue receiving the fewest numbers of

“Somewhat in Favor” votes was that related to stronger restrictions on development in the flood plains.

The highest levels “Somewhat in Opposition” votes were cast for using public funds to restore historic buildings (question 8d) at 15% of responses. Thirteen percent of the voters were “Somewhat in Opposition” to having more bicycle paths (question 8a) and to widening streets and highways to accommodate more traffic (question 8i).

Another 14% of respondents were “Strongly Opposed” to widening streets and highways to handle more traffic (question 8i), developing more bicycle paths (question 8a) and developing additional rail transit. Making it easier to walk in the city (question 8n) garnered the fewest “Somewhat Opposed” (4%) and “Strongly Opposed” (3%).

Although no description was provided of the methodology used, it appears from the consultants’ summary of voting results that they tallied the percentages of votes cast in all categories of response for every question, and subsequently summarized the percentages of votes for all levels of positive responses, and reported on only the highest levels of combined positive responses.

No mention was made of the totals, weight or impact of the negative and neutral responses, leaving the impression that they were not taken into consideration in the analysis, although their inclusion might well strengthen and provide depth to the information presented in the summary of results, particularly if these results were destined to advise city planners on how to project budgets for development activities. For example, using the consultant’s own methodology of combining all votes of like positiveness and negativeness, it might have been of interest that in question 8, highest

levels of opposition were expressed for creating more bike paths (27% “Somewhat Opposed” or “Strongly Opposed”), using public funds to restore historic buildings (27%), and widening streets and highways to accommodate higher volumes of traffic. An interesting point might be that almost as many votes (25%) were cast in opposition to building additional rail transit. Similarly, the highest levels of non-responses were related to adding more express bus service (8% were not sure or had no response), expanding frequency and routes for bus service (8% not sure or had no response), increasing business tax incentives for locating new businesses in depressed areas (7% not sure or had no response), and building additional rail transit (7% not sure or no response).

If the consultants compared responses or combined any options for addressing concerns or for developing action plans, these were not reported on the summary of results. Perhaps of interest would have been the fact that the combined percent of votes expressing no opinion or opposition on the issue of new light rail in the city totals 32%, almost one-third of the participants of this 2003 survey. In 2007, a major and somewhat contentious development activity in the city has been the identification and discussion of placement for new light rail lines.

## **B.2. EMYCIN Transformation of Phone Survey Results Data**

The Phone Survey employed several question formats. Questions 3, 4, and 7 offered the same response options as were offered in the Citizens’ Congress voting—that

is, an “Agree” option, a “Disagree” option, and a “Same” or “No difference” option—with the exception that the Phone Survey also offers a “Not Sure/No Answer” (NS/NA) option for every question. For the purposes of this study, it was decided that “NS/NA” votes were considered as “non-responses”, and “Same” votes were considered votes that expressed an opinion, although the weight of the opinion was zero and thus constituted a different type of “non-response”. Due to this difference between the “Same” and the “NS/NA” votes, their “zero” weights were counted into the Index calculations differently, although both were taken into consideration. Thus, these three questions could be transformed using the same procedure as that used in transforming the results of the Citizens’ Congress voting, with the exception that an additional technique was used to remove the “NS/NA” responses before calculating the Range. This technique is described in detail in the next section.

Questions 2, 5, 6 and 8 offered respondents more options to agree and disagree with the question content. For the purposes of this study, the “Excellent” and “Good” responses in question 2 were treated as positives, and weighted at +0.75 and +0.25, respectively, on the +1/-1 scale. “Fair” was treated as somewhat negative at a value of –0.25, and “Poor” was treated as strongly negative, and assigned a weight of –0.75. Based on this assignment of weight, it was decided that questions 2 and 8 offered 2 positive and two negative response options, plus the “NS/NA” option.

Question 5 asked participants to express three levels of “Concern” (“Very Great Concern”, “Great Concern”, and “Somewhat of a Concern”), plus the NS/NA category, but added a neutral option (“No Concern”) as a fifth choice. Because all of these options



expressed the relative strength of the negative “concern” about the scenarios offered, the weight levels assigned to the response options were +0.75, +0.50, and +0.25, respectively, according to the logical weights along the +1/-1 scale, in addition to the “No Concern” and NS/NA options that were weighted as “0” or inconclusive.

Question 6 offered two levels of positive response (“Strongly Favor”, “Somewhat Favor”, assigned weights of +0.75 and +0.25, respectively) and two levels of negative response (“Somewhat Oppose”, “Strongly Oppose”, weighted at -0.25 and -0.75, respectively), in addition to the NS/NA option.

The multiple levels of positive and negative responses offered in these four questions suggested the use of a different technique to calculate the overall Index for each question, as is described in section C.2.b.

#### **B.2.a. Removing the Non-responses: Calculating the Range for Each Statement**

When transforming the Citizens’ Congress voting results, the Range was reduced proportionally to the number of non-responses by eliminating the “Neutral” responses from the total number of responses for each question. In the case of the Phone Survey, Questions 3, 4 and 7 were structured similarly to the Citizens’ Congress questions in that they offered one positive response option, one negative response option, and a “Same” option. The difference was that the Phone Survey questions also offered a “NS/NA” response. Therefore the transformation of responses for these Phone Survey questions supported the use of a modified procedure (Loh 2007) for calculation of the Range in

order to allow both the non-responses and the neutral responses to be counted when calculating total weight of the individual statements.

The first step in using this modified procedure for transforming this survey data was to make the Range proportional to the number of non-responses. This two-step process began with eliminating the non-responses—in this case, the “NS/NA” responses—and subsequently eliminating the neutrals or “Same” votes during the Range calculation step. The objective of eliminating the “NS/NA” responses was to permit the researcher to determine the weight of each vote that represented an actual opinion about the questions, by distilling the total responses down to “opinion” responses, rather than leaving in votes that actually expressed no opinion. By removing the “NS/NA” votes, a new total number of responses (N) was calculated for each question.

Using question 3 as an example, and using the original number of 1002 total responses N, the survey results indicate that 4% of respondents indicated that they were Not Sure or had No Answer. By multiplying the original number of respondents (N) by 0.04, one calculates that 40 participants responded that they were “Not Sure/had No Answer”. The Phone Survey results indicated that another 39% (391 respondents) voted that things had gotten “Better” in the city over the last 10 years, 28% (281 respondents) considered conditions to have gotten “Worse”, and another 28% (281 respondents) thought things had stayed the “Same”.

By removing the 40 “NS/NA” responses from the original N of 1002, the new N became 962 opinion-expressing votes. To calculate the new percentage of votes cast in each category based on the reduced N, the number of votes originally cast as “Better”

(391) was divided by the new N of 962 responses instead of the original 1002, and gave a new total of 41% of voters expressing the opinion that the city had become “Better” ( $(1002 \times 0.39)/962 = 0.4064$  rounded to 0.41, or 41%). Recalculating the other categories of response for question 3, it was found that 29% of respondents considered the city as having become “Worse” and 30% considered that it had remained the same.

The Range was subsequently calculated using equation (1), where the “new” number of total responses represented the “total responses”. Responses to questions 4 and 7 were transformed using this same two-step procedure to calculate the Range.

Questions 2, 6 and 8 offered multiple positive and negative response options, as well as the option of “Not Sure/No Answer”. No “Neutral” or “Same” option was offered. The Range for these questions was calculated using equation (1) as above, with the “NS/NA” votes considered the non-responses.

Question 5 was structured similarly to questions 2 and 8 in that it offered multiple positive and negative response options, but differed in that it offered both a “Neutral” as well as a “NS/NA” category for every statement, and thus justified the use of the two-step technique used in questions 3, 4 and 7 to eliminate the influence of zero-weight votes. Thus, using question 5d as an example, and the original number of 1002 total responses N, the survey results indicated that 16% of the respondents (or 160 people) expressed “Very Great Concern”, 30% expressed “Great Concern”, 23% expressed “Somewhat Concern”, 9% indicated “No Concern” and another 11% (110 people) were not sure and thus expressed no answer. By removing the 11% of “NS/NA” responses, or 110 votes, from the 1002 original responses, the new N or total responses

for that issue was reduced to 892 opinion-expressing votes. Going back to the “Very Great Concern” votes, to calculate the new percentage of votes cast, the number of votes originally cast as of “Very Great Concern” (160 votes) was divided by the new total number of 892 responses instead of the original 1002, and gave a new total of 18% of voters expressing “Very Great Concern” ( $(1002 \times 0.16)/892 = 17.97\%$ , rounded to 18%). In the same way, new percentages for “Great Concern” were calculated to give a new percentage (34%) of “Great Concern” votes cast, the new percentage of “Somewhat Concerned” was calculated to be 26%, and the new percentage of “No Concern” was calculated to be 21%.

The Range “R” for each question was calculated by using the same equation (1):

$$R = \frac{(\text{Total number of responses} - \text{Number of non - responses})}{\text{Total number of responses}} \quad (1)$$

where:

“Total number of responses” = the original number of responses (Q2, Q6, Q8),

“Number of non-responses” = NS/NA responses (Q2, Q6, Q8),

“Total number of responses” = new total of responses after removing NS/NA responses (Q3, 4, 5 and Q7), and

“Number of non-responses” = number of “Same” or “No Difference” votes.

Table 14 below presents the phone survey results partially transformed from calculating the Range.

Table 14. 2003 Phone Survey Results – Partially Transformed, with Range

(Number of respondents: 1002)								
(Data presented in decimal format)								
	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>NS/NA</u>	<u>Number</u> <u>NS/NA</u>	<u>New Total</u> <u>Responses N</u>	<u>Range</u>
Q.2. How would you rate:								
a. Job opportunities	0.03	0.30	0.40	0.22	0.06	60	942	0.9400
b. Public school quality	0.30	0.27	0.40	0.21	0.08	80	922	0.9200
c. Arts/culture opportunities	0.25	0.44	0.19	0.06	0.06	60	942	0.9400
d. Air quality	0.01	0.11	0.33	0.54	0.01	10	992	0.9900
e. Public safety/crime control	0.01	0.28	0.46	0.24	0.02	20	982	0.9800
f. Racial/ethnic relations	0.03	0.37	0.42	0.14	0.04	40	962	0.9600
g. Green space/parks	0.04	0.41	0.37	0.16	0.03	30	972	0.9700
h. Recreation opportunities	0.09	0.48	0.30	0.09	0.04	40	962	0.9600
i. Health care for low income citizens	0.03	0.19	0.28	0.32	0.16	160	842	0.8400
j. Drainage/flood control	0.00	0.15	0.34	0.48	0.04	40	962	0.9600
k. Mobility in city	0.03	0.23	0.32	0.40	0.02	20	982	0.9800
l. The city as place to live	0.14	0.55	0.25	0.05	0.01	10	992	0.9900
Q.3. In the last 10 years, the city has gotten:	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>Number</u> <u>Same</u>	<u>NS/NA</u>	<u>Number</u> <u>NS/NA</u>	<u>New Total</u> <u>Responses N</u>	<u>Range</u>
	0.39	0.28	0.29	291	0.04	40	962	0.6979
Q.4. In the next 10 years, the city will become:	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>Number</u> <u>Same</u>	<u>NS/NA</u>	<u>Number</u> <u>NS/NA</u>	<u>New Total</u> <u>Responses N</u>	<u>Range</u>
	0.43	0.22	0.28	281	0.06	60	962	0.7021
Q.5. How concerned are you about:	<u>V. Great</u>	<u>Great</u>	<u>Somewhat</u>	<u>No</u>	<u>Number</u>	<u>Number</u>	<u>New Total</u>	
	<u>Concern</u>	<u>Concern</u>	<u>Concerned</u>	<u>Concern</u>	<u>No</u>	<u>NS/NA</u>	<u>Responses N</u>	<u>Range</u>
	(Modified)	(Modified)	(Modified)	(Modified)	Concern			
a. Difficult to get around	0.23	0.35	0.27	0.13	130	10	992	0.8687
b. Deteriorating neighborhoods	0.17	0.37	0.31	0.15	140	40	962	0.8542
c. Too many below poverty line	0.21	0.42	0.26	0.11	100	90	912	0.8901
d. Shortage of affordable housing	0.18	0.34	0.26	0.21	190	110	892	0.7865

Table 14 continued

					<u>Number</u>			
Q.5. How concerned are you about:	<u>V. Great</u>	<u>Great</u>	<u>Somewhat</u>	<u>No</u>	<u>No</u>	<u>Number</u>	<u>New Total</u>	
	<u>Concern</u>	<u>Concern</u>	<u>Concerned</u>	<u>Concern</u>	<u>Concern</u>	<u>NS/NA</u>	<u>Responses N</u>	<u>Range</u>
	(Modified)	(Modified)	(Modified)	(Modified)				
e. Inadequate public education	0.27	0.40	0.21	0.13	120	90	912	0.8682
f. Shortage of public parking	0.24	0.32	0.24	0.20	190	31	971	0.8039
g. Loss of open space to development	0.22	0.37	0.22	0.19	180	50	952	0.8105
h. Shortage of good public transport	0.21	0.31	0.24	0.22	210	60	942	0.7766
i. Shortage of nearby park space	0.12	0.20	0.25	0.44	421	40	962	0.5625
j. Insufficient city/suburban cooperation on problems	0.20	0.34	0.28	0.19	170	110	892	0.8090
k. Low neighborhood diversity	0.08	0.21	0.30	0.43	391	90	912	0.5715
l. Lack of local vision/planning	0.24	0.41	0.25	0.11	100	50	952	0.8947
m. Need more sidewalks	0.27	0.36	0.23	0.15	140	50	952	0.8526
Q.6. Some cities have general plan to guide future growth, but the city does not. How do you feel about creating a general plan for the city?	<u>Strongly</u>	<u>Somewhat</u>	<u>Somewhat</u>	<u>Strongly</u>		<u>Number</u>		
	<u>Favor</u>	<u>Favor</u>	<u>Disfavor</u>	<u>Disfavor</u>	<u>NS/NA</u>	<u>NS/NA</u>		<u>Range</u>
	0.59	0.23	0.06	0.06	0.06	60		0.9400
Q.7. Likelihood of voting for a candidate offering strong development Guidelines	<u>More</u>	<u>Less</u>	<u>No</u>	<u>No</u>		<u>Number</u>	<u>New Total</u>	
	<u>Likely</u>	<u>Likely</u>	<u>Difference</u>	<u>Difference</u>	<u>NS/NA</u>	<u>NS/NA</u>	<u>Responses N</u>	<u>Range</u>
	0.57	0.10	0.23	230	0.11	110	892	0.7416
Q.8. How do you feel about the following development proposals?	<u>Strongly</u>	<u>Somewhat</u>	<u>Somewhat</u>	<u>Strongly</u>		<u>Number</u>		<u>Range</u>
	<u>Favor</u>	<u>Favor</u>	<u>Oppose</u>	<u>Oppose</u>	<u>NS/NA</u>	<u>NS/NA</u>		
a. More bicycle paths	0.32	0.37	0.13	0.14	0.03	30		0.9701
b. Stronger restrictions on development in flood plains	0.60	0.23	0.07	0.06	0.04	40		0.9601

Table 14 continued

Q.8. How do you feel about the following development proposals?	<u>Strongly</u> <u>Favor</u>	<u>Somewhat</u> <u>Favor</u>	<u>Somewhat</u> <u>Oppose</u>	<u>Strongly</u> <u>Oppose</u>	<u>NS/NA</u>	<u>Number</u> <u>NS/NA</u>	<u>Range</u>
c. Business tax incentives for locating in depressed areas	0.41	0.35	0.10	0.08	0.07	70	0.9301
d. Using public funds to restore historic buildings	0.31	0.38	0.15	0.12	0.04	40	0.9601
e. Using public funds for parks	0.41	0.39	0.10	0.06	0.03	30	0.9701
f. Green space/wetlands off limits to development	0.48	0.33	0.08	0.06	0.06	60	0.9401
g. Increasing express bus service	0.40	0.35	0.11	0.07	0.08	80	0.9202
h. Additional rail transit	0.42	0.26	0.11	0.14	0.07	70	0.9301
i. Street/highway widening for more Traffic	0.39	0.30	0.13	0.14	0.04	40	0.9601
j. More curbside recycling	0.49	0.33	0.08	0.05	0.06	60	0.9401
k. Imposing new regulations to reduce air pollution	0.61	0.24	0.06	0.06	0.02	20	0.9800
l. Expand frequency and routes for bus service	0.44	0.31	0.09	0.07	0.08	80	0.9202
m. More control of land use and Urban sprawl	0.39	0.31	0.10	0.07	0.13	130	0.8703
n. Make it easier to walk in city	0.57	0.30	0.04	0.03	0.06	60	0.9401

As demonstrated in the presentation of Citizens' Congress II voting results, the Range again provides a one-number statement of how important or understandable each Phone Survey question or scenario was to the survey participants. The Range numbers in table 14 show that voters considered a substantial number of questions important and comprehensible enough to express their opinions. For example, in question 2, a full 99% of participants expressed an opinion about air quality (question 2d) and the city as a place to live (question 2l), and 98% expressed some opinion about public safety and crime control (question 2e), and about mobility in the city (question 2k). On the issues of availability of recreational opportunities (question 2h) and drainage and flood control (question 2j), 96% of participants expressed some opinion.

On the other hand, one can also see from a quick glance at the Range that many respondents selected not to cast a vote for a substantial number of the questions. Only 70% of voters expressed an opinion about improvement or lack of improvement in the city over the last 10 years (question 3), with 30 % not expressing any opinion. And only 71 % of voters were willing to express their belief about future improvements or lack of improvements in the city (question 4). Also easy to spot in question 5 is the relatively low response to the issue of having park space near home (question 5i) with only 56% of participants expressing an opinion, and to the neighborhood diversity issue (question 5k) with only 57% of voters expressing an opinion. Other interesting points pop out in the Range as well. For example, only 74 % of respondents expressed any opinion about the power of a candidate equipped with strong development guidelines to attract their votes (question 6). This kind of information easily accessible from the single figure of the



Range may, in itself, be of potential usefulness to planners seeking to identify issues of most or least interest to citizens among a wide array of issues.

### **B.2.b. Calculating the Positive or Negative Weight of Each Statement: The Index**

The next step in transformation of the Phone Survey responses focused on calculating an Index for each statement that represents the precise percentages of different levels of positive and negative responses. From the large matrix of responses in questions 2, 5, 6 and 8, it is clear there is a wealth of information on citizen opinions presented in these numbers. As in the Citizens' Congress voting, here the Index offers a tool for understanding the impact of the positive, negative, and neutral aspects of each of these votes, information that might be useful in designing development scenarios that would be preferred by a majority of voters, create a feeling in the resident population of being valued participants in directing the city's growth, and gain their approval at the polls.

The responses to each of these questions included a percentage of very positive, a percentage of somewhat positive, percentages of somewhat negative and very negative, and percentage of neutral votes. The EMYCIN pair-wise combination methodology used to combine differently-weighted statements in the analysis of the Citizens' Congress voting results is used here within each statement to ensure that the "Strongly Approve" responses are weighted more positively (+0.75) than the "Somewhat Approve" responses weighted at +0.25, and the "Strongly Disapprove" votes weighted

more negatively at -0.75 than the “Somewhat Disapprove” votes weighted at -0.25 (Loh 2007).

In the special case of Question 5 that offers 4 levels of “Concern” as response options, to allow measurement of the largeness of the concern only positive weights (0.75, 0.5, 0.25) and “zero” weight were assigned to “Very Great Concern”, “Great Concern”, “Somewhat of a Concern”, and “No Concern” respectively. This weighting reflected that any expression of concern, whether large or small (with the exception of “No Concern”) constituted a positive response of worry about the negative scenarios listed in the question.

In Questions 2, 6 and 8, the first pair-wise combination combined the two positive percentages (“strongly positive” and “somewhat positive”) using EMYCIN equation (3). This step generated a new positive number representing the first partial transformation of the response. The second pair-wise combination in questions 2, 6 and 8 employed EMYCIN equation (4) to combine the two negative percentages (“somewhat negative”, “strongly negative”), generating a new negative number representing the second partial transformation. The third pair-wise combination used EMYCIN equation (5) to combine the positive partially transformed number and the negative partially transformed number, and generated a final or third pair-wise combined number. The Range, calculated earlier for each statement in order to incorporate the effect of non-responses and neutral votes, was multiplied by the final pair-wise combined number for that statement to derive a final Index for that statement.

In the case of question 5, where all three levels of “concern” were weighted positively, and “No Concern” responses were eliminated as neutrals in the calculation of the Range, only two pair-wise combinations were necessary to arrive at a final partial transformation number: combination of the “Very Great Concern” with the “Great Concern” responses, and the subsequent combination of that product with the “Somewhat Concerned” responses. The Index was then calculated by multiplying the second pair-wise combined number by the Range.

Questions 3, 4 and 7 offered only one positive, one negative and a neutral response, plus the NS/NA option that was taken into consideration during calculation of the Range. This question format allowed the researcher to use the same methodology [equation (2)] to calculate the Index for the question as was used to transform the results of the Citizens’ Congress voting.

Table 15 provides the final Index number for all Phone Survey questions considered in this study.

Table 15. 2003 Phone Survey Results – Partially Transformed, with Index

Q.2.	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>	<u>Range</u>	<u>3<sup>rd</sup> Pair-wise Combination</u>	<u>Index</u>	<u>Pair-wise Combination of Statements</u>
a. Job opportunities	0.03	0.30	0.40	0.22	0.940	-0.17902	-0.1683	
b. Public school quality	0.30	0.27	0.40	0.21	0.920	0.02864	0.0263	-0.1458
c. Arts/culture opportunities	0.25	0.44	0.19	0.06	0.940	0.17106	0.1608	0.0131
d. Air quality	0.01	0.11	0.33	0.54	0.990	-0.43441	-0.4301	-0.4225
e. Public safety/crime control	0.01	0.28	0.46	0.24	0.980	-0.21378	-0.2095	-0.5435
f. Racial/ethnic relations	0.03	0.37	0.42	0.14	0.960	-0.09701	-0.0931	-0.5860
g. Green space/parks	0.04	0.41	0.37	0.16	0.970	-0.18268	-0.0802	-0.6192
h. Recreation opportunities	0.09	0.48	0.30	0.09	0.960	0.03689	0.0354	-0.6052
i. Health care for low income citizens	0.03	0.19	0.28	0.32	0.840	-0.24087	-0.2023	-0.6851
j. Drainage/flood control	0.00	0.15	0.34	0.48	0.960	-0.39158	-0.3759	-0.8035
k. Mobility in city	0.03	0.23	0.32	0.40	0.980	-0.30098	-0.2950	-0.8614
l. The city as place to live	0.14	0.55	0.25	0.05	0.990	0.11880	0.1176	-0.8430
Q.3. In the last 10 years, has the city gotten:	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>Number</u>	<u>New</u>	<u>Range</u>	<u>Index</u>	
(Note: "Same" votes = Neutral)	0.39	0.28	0.29	291	962	0.6979	-0.2688	
Q.4. In the next 10 years, will the city become:	<u>Better</u>	<u>Worse</u>	<u>Same</u>	<u>Number</u>	<u>New</u>	<u>Range</u>	<u>Index</u>	
(Note: "Same" votes = Neutral)	0.43	0.22	0.28	281	942	0.7021	-0.1214	
Q.5. How concerned are you about:	<u>New %</u>	<u>New %</u>	<u>New %</u>	<u>New %</u>		<u>2<sup>nd</sup> Pair-wise</u>		<u>Pair-wise</u>
	<u>V. Great</u>	<u>Great</u>	<u>Somewhat</u>	<u>No</u>		<u>Combination</u>	<u>Index</u>	<u>Combination</u>
	<u>Concern</u>	<u>Concern</u>	<u>Concerned</u>	<u>Concern</u>	<u>Range</u>			<u>of Statements</u>
a. Difficult to get around	0.23	0.35	0.27	0.13	0.8687	0.36655	0.3184	
b. Deteriorating neighborhoods	0.17	0.37	0.31	0.15	0.8542	0.34458	0.2943	0.5190
c. Too many below poverty line	0.21	0.42	0.26	0.11	0.8901	0.37662	0.3352	0.6803
d. Shortage of affordable housing	0.18	0.34	0.26	0.21	0.7866	0.32705	0.2572	0.7625
e. Inadequate public education	0.27	0.40	0.21	0.13	0.8682	0.39627	0.3440	0.8442
f. Shortage of public parking	0.24	0.32	0.24	0.20	0.8039	0.35046	0.2817	0.8881
g. Loss of open space to development	0.22	0.37	0.22	0.19	0.8105	0.35704	0.2894	0.9205

Table 15 continued

Q.5. How concerned are you about:	<u>New %</u> <u>V. Great</u> <u>Concern</u>	<u>New %</u> <u>Great</u> <u>Concern</u>	<u>New %</u> <u>Somewhat</u> <u>Concerned</u>	<u>New %</u> <u>No</u> <u>Concern</u>	<u>Range</u>	<u>2<sup>nd</sup> Pair-wise</u> <u>Combination</u>	<u>Index</u>	<u>Pair-wise</u> <u>Combination</u> <u>of Statements</u>
h. Shortage of good public transport	0.21	0.31	0.24	0.22	0.7766	0.33266	0.2583	0.9410
i. Shortage of nearby park space	0.12	0.20	0.25	0.44	0.5625	0.23445	0.1319	0.9488
j. Insufficient city/suburban cooperation on problems	0.20	0.34	0.28	0.19	0.8090	0.34412	0.2784	0.9631
k. Low neighborhood diversity	0.08	0.21	0.30	0.43	0.5715	0.21862	0.1249	0.9677
l. Lack of local vision/planning	0.24	0.41	0.25	0.11	0.8947	0.12231	0.0565	0.9695
m. Need more sidewalks	0.27	0.36	0.23	0.15	0.8526	0.11243	0.0494	0.9710
Q.6. Some cities have general plan to guide Future growth, but the city does not. How do you feel about creating a general plan for the city?	<u>Strongly</u> <u>Favor</u>	<u>Somewhat</u> <u>Favor</u>	<u>Somewhat</u> <u>Disfavor</u>	<u>Strongly</u> <u>Disfavor</u>	<u>Range</u>	<u>3<sup>rd</sup> Pair-wise</u> <u>Comparison</u>	<u>Index</u>	
	0.59	0.23	0.06	0.06	0.9400	0.44127	0.4148	
Q.7. Likelihood of voting for a candidate offering Strong development guidelines?	<u>Number</u> <u>More</u> <u>Likely</u>	<u>Number</u> <u>No</u> <u>Difference</u>	<u>Number</u> <u>Less</u> <u>Likely</u>		<u>Range</u>		<u>Index</u>	
	571	230	100		0.7416		0.3784	
Q.8. How do you feel about the following development proposals?	<u>Strongly</u> <u>Favor</u>	<u>Somewhat</u> <u>Favor</u>	<u>Somewhat</u> <u>Oppose</u>	<u>Strongly</u> <u>Oppose</u>	<u>Range</u>	<u>3<sup>rd</sup> Pair-wise</u> <u>Combination</u>	<u>Index</u>	<u>Pair-wise</u> <u>Combination</u> <u>of Statements</u>
a. More bicycle paths	0.32	0.37	0.13	0.14	0.9701	0.20348	0.1974	
b. Stronger restrictions on development in flood plains	0.60	0.23	0.07	0.06	0.9601	0.44767	0.4298	0.5423
c. Business tax incentives for locating in depressed areas	0.41	0.35	0.10	0.08	0.9301	0.31069	0.2890	0.6746
d. Using public funds to restore historic buildings	0.31	0.38	0.15	0.12	0.9601	0.20695	0.1987	0.7393
e. Using public funds for parks	0.41	0.39	0.10	0.06	0.9701	0.32883	0.3190	0.8224
f. Green space/wetlands off limits to development	0.48	0.33	0.08	0.06	0.9401	0.34432	0.3237	0.8799
g. Increasing express bus service	0.40	0.35	0.11	0.07	0.9202	0.27596	0.2539	0.9104
h. Additional rail transit	0.42	0.26	0.11	0.14	0.9301	0.21055	0.1958	0.9279
i. Street/highway widening for more traffic	0.39	0.30	0.13	0.14	0.9601	0.19073	0.1831	0.9411
j. More curbside recycling	0.49	0.33	0.08	0.05	0.9401	0.35950	0.3380	0.9610

Table 15 continued

Q.8. How do you feel about the following development proposals?	<u>Strongly</u>	<u>Somewhat</u>	<u>Somewhat</u>	<u>Strongly</u>	<u>3<sup>rd</sup></u>	<u>Pair-wise</u>	<u>Index</u>	<u>Pair-wise</u>
	<u>Favor</u>	<u>Favor</u>	<u>Oppose</u>	<u>Oppose</u>				
k. Imposing new regulations to reduce air pollution	0.61	0.24	0.06	0.06	0.9800	0.45773	0.4486	0.9785
l. Expand frequency and routes for bus service	0.44	0.31	0.09	0.07	0.9202	0.30221	0.2781	0.9845
m. More control of land use and urban sprawl	0.39	0.31	0.10	0.07	0.8703	0.29345	0.2554	0.9885
n. Make it easier to walk in city	0.57	0.30	0.04	0.03	0.9401	0.43710	0.4109	0.9932

The Index numbers show the overall positiveness or negativeness of specific statements of interest. For example, as reported in the consultant's summary of voting results for this survey, the city's voters responded most positively in question 2 about arts and cultural opportunities in the city (question 2c), indicating that 65% rated it as "Excellent" or "Good". However, taking a look at the breakdown of votes cast in each of these categories, one sees that of the original 1002 respondents, only 25% of the 69% ranked arts and cultural opportunities as "Excellent" and the rest ranked it as "Good". Using the EMYCIN Index calculation as described in this study, the arts and cultural opportunities Index actually came out at +0.1893 on the +1/-1 scale. Because this technique takes into account that all levels of response were weighted, and almost one-third of the voters ranked the city as either "Fair" (19%, weighted at -0.25), "Poor" (6% weighted at -0.75) and another 6% cast no vote, this issue came out with an overall Index rating just slightly below the "Somewhat Positive" point of 0.25 on the scale, giving some perspective on the data that led to the consultant's analysis that 65% rated it as "Excellent" or "Good".

Take another aspect of the city mentioned by the consultant as having received high numbers (69%) of positive responses: its desirability as a place to live (question 2l). If one looks at the actual responses for this issue, it can be seen that most of the positive votes (55%) were cast in the "Good" category earning weights of 0.25, instead of the "Excellent" category weighted at 0.75 that gained only 14% of the votes, and that 25% voted the city as only "Fair" earning weights of -0.25 for these votes. Another 5% voted the city as "Poor", earning very negative weights of -0.75 for these votes. Using the

EMYCIN technique to calculate the statement's Index, the combination of these weighted responses produced an only slightly positive Index of +0.1386.

The third of the most highly marked aspects of the city mentioned by the consultant's report was the recreational opportunities offered by the city (question 2h). The consultant's methodology combined the voters' "Excellent" and "Good" responses to arrive at a 57% approval rate. This might sound fairly positive to the citizens. But using the EMYCIN technique to combine different categories of positive and negative votes for this aspect of the city, according to votes cast by participants in this survey, the Index for recreational opportunities is calculated to be +0.0359 or rounded up, 0.04. When placed on a scale from -1 to +1, this Index is minutely on the positive side of "inconclusive" or zero, clearly taking into account that 48 out of 100 votes considered this aspect of the city as "Good" (weighted at only 0.25), 30% of the voters considered recreational opportunities to be only "Fair" (weighted at -0.25), and 9% considered recreational opportunities to be "Poor" (weighted at -0.75).

In the same question 2, the consultant's report notes the lowest marks going to three aspects of the city. The worst ranked aspect was air quality (question 2d), with more than half (54%) of respondents giving it a "Poor" ranking. Using the EMYCIN formulas to evaluate the survey responses on this aspect of the city, the 54% of "Poor" votes were weighted at -0.75, and another 33% were weighted at -0.25 in the "Fair" category, with only 11% of the votes weighing in at +0.25 in the "Good" category, and a mere 1% of votes weighing in at +0.75 in the "Excellent" category, to give a moderately negative overall Index of -0.5042 for this issue. This rating would have been even more



negative if not taking into consideration the 33% of voters who ranked this aspect of the city as “Fair”, weighted at the less negative  $-0.25$  and thus tending to pull the total Index only slightly in a more negative direction than if these votes had been rated at “Poor”. In addition, the 11% of vote rating air quality as “Good” (weighted at  $0.25$ ) and 1% rating it as “Excellent” (weighted at  $0.75$ ) pulled the overall Index for this aspect of the city in a positive direction, or in this case, towards zero and thus keeping the negative rating at “Moderately Negative”.

The survey summary also called attention to drainage and flood control (question 2j) as another aspect of the city given low rating by survey participants. The report notes that 48% of voters rated this aspect of the city as “Poor”. However, 34% of responses stated this issue is “Fair”, weighted at  $-0.25$ , and another 15% stated the aspect of the city was “Good”. The actual overall Index for drainage and flood control was  $-0.4572$ . Thus this ranks at not quite “Moderately Negative” on the  $+1/-1$  scale.

Using the Index to compare the weights of various statements, one can look more closely at aspects of the city rated in question 2 and see that there is a great deal of available information that apparently was not used by the consultant. For example, only four aspects of the city rated above the level of “0” or inconclusive on the  $+1/-1$  scale. These include the 3 mentioned above, and quality of the public school system (question 2b), responses for which were calculated using the EMYCIN technique to give an Index of  $0.0051$ , or minutely positive. The remaining aspects of this city put to a citizen vote came up on the negative portion of the scale. Note in fig. 8 below that the negative responses extend farther towards  $-1$  than the positive responses extend towards  $+1$ , and

that the overall weighting of these aspects of the city are lower than the impression given by the consultant's report. The most positively rated aspect of the city was less than "Somewhat Positive". The good news is that no aspect of the city was so bad that it ranked as "Strongly Negative".

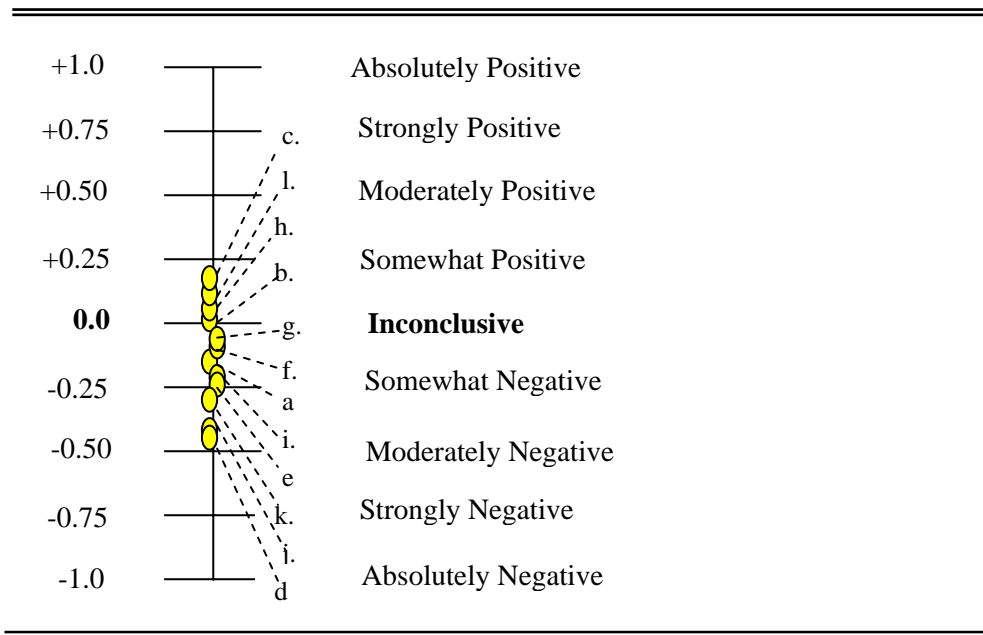


Figure 8. Phone Survey Question 2 Responses Mapped on Scale of +1/-1

In another example, the original summary of the Phone Survey results pointed out that in question 3, more voters gave positive (39%) than negative (28%) votes concerning in what direction change has proceeded in the city has changed over the last 10 years, and in question 4 it was reported that more respondents gave positive (43%) than negative (22%) votes for how they expect the city to change in the next 10 years. With no intention to undermine the positive take on this vote, in applying the Index calculation, one finds that the Index for the votes cast on the issue of the last 10 years is

-0.2688. This indicates that a representative cross-section of the city's voters is slightly more than Somewhat Negative about the last 10 years. The Index for question 4 concerning perspectives on the next 10 years in the city was calculated at -0.1214, again negative but slightly less negative than opinions about the past.

Question 5 addresses ongoing and dynamic situations within the city, and was designed to obtain a measure of voters' "personal concern" about these dynamic situations. Recall that the consultants' summary of voting on this complex question combined the responses in the "Very Great Concern" and "Great Concern" categories, and reported that lack of vision or planning in dealing with local problems (62%), the inadequacy of the public schools to educate the city's children (61%), the lack of good sidewalks for walking in the city (60%), and difficulty in getting around the city (58%) were of the greatest concern to voters in the city.

The inadequacy of the public schools in providing education (question 51) was calculated at an Index of 0.3495 to be the situation of highest personal concern to survey participants using the EMYCIN technique. Twenty-seven percent of responses (modified from 25% by the 2-step removal of non-responses when calculating the Range) indicated that this situation caused them "Very Great Concern" weighted at +0.75. An additional 40% of responses (modified from 36%) indicated the situation caused them "Great Concern", weighted at +0.5. These combined very positively weighted categories represent 65% of all responses to this question. Another 21% (modified from 19%) felt the situation was "Somewhat of a Concern", and these votes weighted at +0.25 pushed the total statement weight slightly more in a positive direction.

The zero-weighted votes of the 13% of respondents (modified from 12%) who stated that this situation was of “No Concern” to them pulled the overall level of “Concern” back slightly towards zero.

Concern about the inadequacy of public education was followed closely by the issue of too many citizens living below the poverty line (question 5c) as having the second highest level of concern for voters. After modifications for removal of non-responses, 21% of voters ranked the city’s public education system as a “Very Great Concern”, weighted at +0.75, and another 42% ranked it as a “Great Concern”, votes weighted at +0.5. Together these heavily weighted categories of responses pushed the overall weight of the question towards the positive end of the spectrum. Twenty-six percent of respondents thought this issue was only “Somewhat of a Concern”, votes weighted at 0.25 that pushed the weight of the responses still slightly more in a positive direction. Only the 11% of responses ranking it as “No Concern” at all (with weights of zero) pulled the weight of the overall “Concern” expressed by this vote back towards zero. The Index calculated from these responses was +0.3440, indicating a slightly lower level of concern than the lack of local vision and planning, but still more than Somewhat of a Concern, and less than a Great Concern.

The issue of next highest concern to voters as indicated from the EMYCIN technique was the difficulty of getting around in the city (question 5a). Twenty-three percent of voters rated this issue as a “Very Great Concern” earning weights of +0.75, and another 35% of voters rated this issue as a “Great Concern” earning weights of +0.50. Still another 27% rated this issue as “Somewhat of a Concern”, which votes were

weighted at +0.25. The Index for this issue was calculated to be +0.3184, or more than “Somewhat of a Concern” if plotted on the +1/-1 scale.

As determined using the EMYCIN technique, the fourth most concerning issue turned out to be the deterioration of neighborhoods in the city. While only 17% of respondents indicated this issue was a “Very Great Concern” to them (weighted at +0.75), a whopping 37% voted that it was a “Great Concern” (weighted at +0.50) and another 31% indicated that the issue was at least “Somewhat of a Concern” (weighted at +0.25). Even though 15% voted that this issue caused them “No Concern”, the Index was calculated at +0.2943, placing the neighborhood deterioration issue higher on the “Concern” scale than “Somewhat a Concern”.

Aspects of least concern to the survey participants included the need for more sidewalks (question 5m) with an Index of +0.0494, the lack of local vision and planning (question 5l) with an Index of +0.0565, low neighborhood diversity (question 5k) with an Index of +0.1249, and shortage of nearby park space (question 5i) having an Index of +0.1319.

It is noted that the consultant interpreted the responses to question 5 as indicating that the issue of lack of local vision and planning was voted as causing the highest levels of concern among respondents, whereas the EMYCIN technique that assigns weights to the votes cast in different categories has calculated that this is actually the issue of least concern to voters among all the issues presented. EMYCIN takes into account that 16% of voters cast no opinion at all on this issue, and of those who indicated concern, 59% indicated a lower level of concern, and only 24% indicated a very high level of concern.

The responses from question 5 are plotted on the +1/-1 scale below in fig. 9.

Recall that in this case, the more positive the response, the greater the level of concern expressed by survey participants. Of the 13 issues, four are ranked between “Inconclusive” and “Somewhat Positive” (or “Somewhat a Concern”), indicating an existent but low level of concern. The other nine issues earned enough votes of higher weights to place them above the level of “Somewhat a Concern”. The ranking of these nine issues falls between +0.2572 and +0.3440. This limited spread of rankings indicates that these nine issues are all of similar level of concern to voters in the city, that is, they are within 0.10 of each other in terms of weight of concern. Note that none of the concerns extended beyond the level of “Moderately Positive”, indicating that each concern is of a moderate level of concern or less.

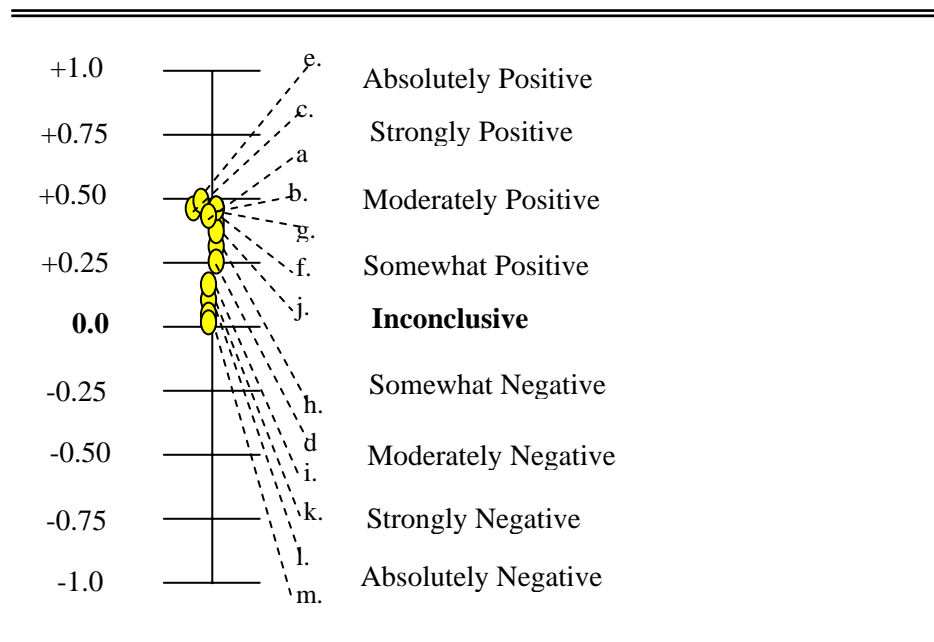


Figure 9: Phone Survey Question 5 Responses Mapped on Scale of +1/-1

All question 5 responses generated positive Index numbers, since the researcher opted to assign positive values to the levels of “concern”. This was done primarily because of the way in which the question was phrased. Since the issues presented were all “problem” issues and thus already negative, the “concern” that was measured was simply a negative opinion whose intensity or level was being measured. Thus no negative responses were offered for rating the “negativeness” of the concern, although a “no concern” was offered as a neutral vote.

The fact that respondents indicated levels of concern from zero concern to “Very Great Concern” is an indication that citizens were unhappy about the scenarios presented. Interpretation would be that these negative opinions were in fact a positive result from the survey, since it shows that voters do not agree with the status quo related to the issues, and could be supportive of changes. Using the EMYCIN technique to evaluate the real level of voter dissatisfaction might provide planners with useful or possibly surprising information about what problems really need resolution, and may also help planners identify issues for which voters had much lower levels of concern, and thus might allow postponement of allocation of resources needed to resolve the problems.

The Index for question 6, concerning voter interest in creating a general plan to guide the city’s future development, was calculated to be 0.4148, or slightly less positive than the “Moderately Positive” weight of 0.5 on the +1/-1 scale.

Question 7 addressed the likelihood of respondents voting for a political candidate offering strong development guidelines. The consultant’s report indicates that

57% of voters would be more willing to support city election candidates offering stronger guidelines for growth. Using the EMYCIN technique of using three partial pairwise combinations with the statement, the Index for this question was calculated to be +0.3784, or about mid-way between the levels of “Somewhat Positive” and “Moderately Positive” on the +1/-1 scale. Stated another way, this ranking would tend to indicate that, as an issue by itself, voters would be slightly more than “Somewhat Positive” about this candidate.

Question 8 asked voters how they felt about a palette of 14 development options, and offered two positive response categories (“Strongly Favor” and “Somewhat Favor”) and two negative response categories (“Somewhat Oppose” and “Strongly Oppose”). The four response categories and 14 development options created a matrix rich with information on voter preferences on these specific development proposals being considered for the city. The consultant’s report, however, indicated only that the participants of the survey strongly favored imposing new regulations to reduce air pollution, stronger restrictions on development in the flood plains, and making it easier for people to walk within the city. No indication was provided of the method used to interpret the survey results, so the researcher made the assumption that the consultant focused primarily on the “Strongly Favor” responses for each statement to derive conclusions.

A slightly more in-depth analysis using the EMYCIN Index calculations confirms that these were indeed the proposals most highly favored by voters. The most highly favored was that of enacting stronger regulations to control air pollution (proposal



8k) with an Index calculated at 0.4486, or just shy of “Moderately Positive” on the +1/-1 scale. Using the percentage of votes cast in each category, the Index was calculated based on 61% of respondents “Strongly Favoring” the proposal with votes weighted at +0.75, another 24% “Somewhat Favoring” it with votes weighted at +0.25, and 6% “Somewhat Opposing” it with votes weighted at -0.25, and another 6% “Strongly Opposing” it with votes weighted at -0.75. Mapped on the +1/-1 scale, the voter response to this most highly favorable issue of all issues presented falls slightly short of the level of Moderately Positive.

On the proposal for stronger restrictions on development in the flood plains (proposal 8b), an Index of 0.4298 was calculated from 60% of respondents “Strongly Favoring” the proposal, 23% voting that they “Somewhat Favor” it, 7% indicating that they “Somewhat Oppose” the proposal, and 6% “Strongly Opposing” it. This proposal ranked second in favorability by the voters.

The issue of finding ways to make it easier to walk in the city (proposal 8n) drew responses indicating that 57% “Strongly Favored” it and 30% “Somewhat Favored” it, with votes weighted at +0.75 and +0.25 respectively in these categories. Only 4% “Somewhat Opposed” this improvement, and 3% “Strongly Opposed” it, votes weighted at -0.25 and -0.75 respectively. The Index calculated from these votes was 0.4109, or not quite as close to “Moderately Positive” as the other two issues.

If one were to use the EMYCIN scale of +1/-1 to map the favorability of the top three proposals according to the consultant’s assessment, these three proposals strongly favored by the respondents would rank at +0.75 or above, as shown in green in fig. 10

below. However, because the EMYCIN technique allows the closer examination of the specific votes cast for each issue, it can be seen in fig. 10 that the favorability of each of these three issues to the voters in the city is actually lower than “Moderately Favorable”.

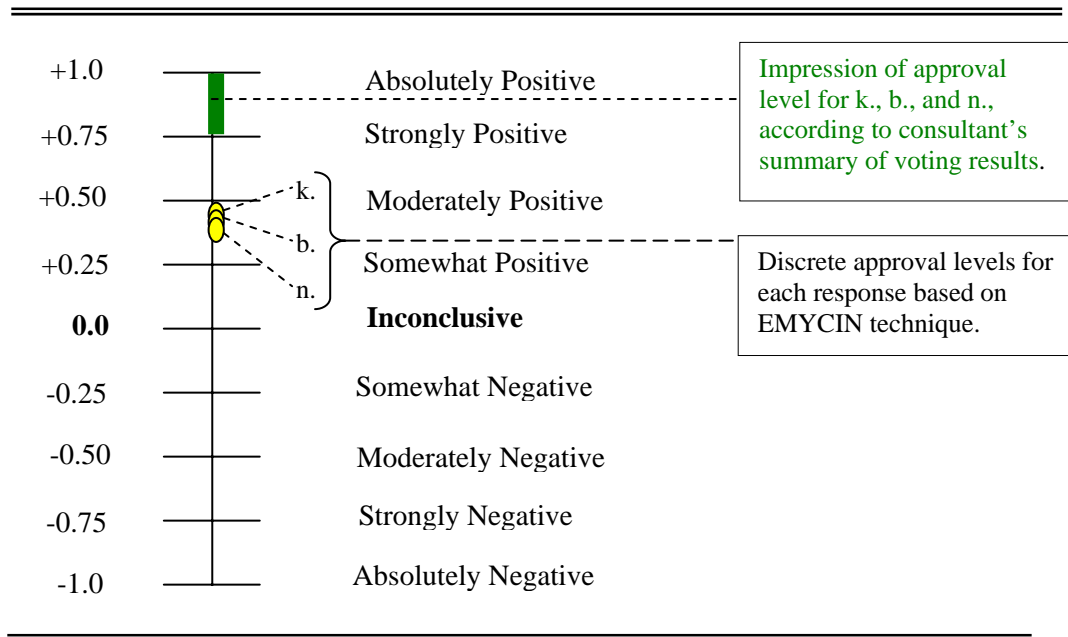


Figure 10: Phone Survey Question 8 – Three Responses Mapped on Scale of +1/-1

Other development proposals that gained high levels of favorability not mentioned by the consultant included instituting more curbside recycling (proposal 8j) that garnered 49% “Strongly Favor” votes weighted at +0.75, 33% “Somewhat Favor” votes weighted at +0.25, respectively, and 8% “Somewhat Oppose” votes and 5% “Strongly Oppose” votes, weighted at -0.25 and -0.75, respectively. The overall Index for this proposal was calculated at +0.3380. Weighing in at almost the same level of approval were two other issues: placing green space and wetlands off-limits to

development (proposal 8f) with an Index calculated to be +0.3237, and using public funds for parks (proposal 8e) with an Index of +0.3190.

Having an overall weighted Index number for each option also greatly facilitates the quick comparison and ranking of different options for development. For example, if one assumes the 14 development actions proposed in question 8 were generated through a community visioning process and put to a referendum for the community to identify and prioritize planning for the next 5 years, and the votes were cast as they appear in the Phone Survey, the Index serves as a strong tool for prioritizing the favorability of the various proposed actions based on voter opinion. The Index numbers calculated from these Phone Survey voting profiles show that voters consider all options positively.

The least positive development action, on the other hand, was clearly the proposal to widen existing streets and highways to accommodate more traffic—something on which many communities spend scarce budgetary funds for “community improvements” but for which this city’s voter responses generated an Index of only +0.1831. The next least positive votes were cast for building additional rail transit (Index of +0.1958), creating more bicycle paths (Index of +0.1974) and using more public funds to restore historic buildings (Index of +0.1987).

Figure 11 shows the placement of all question 8 proposals along the +1/-1 scale for easy comparison of their favorability with the city’s voters.

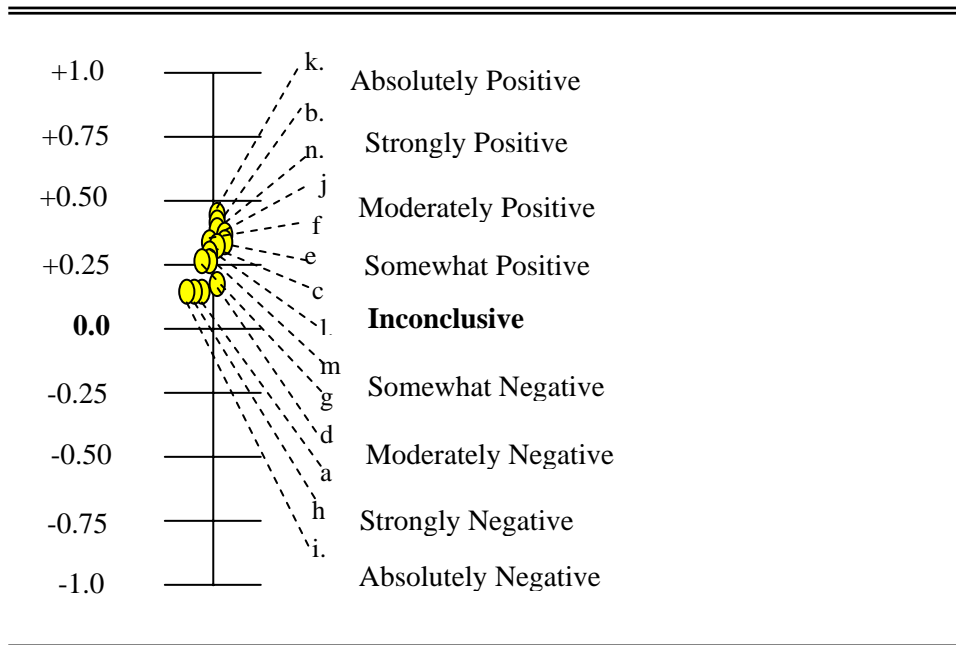


Figure 11: Phone Survey Question 8 Responses Mapped on Scale of +1/-1

A quick scan of this diagram shows that the respondents considered every proposal higher on the scale than proposal 8d “Somewhat Positive”, and that none of the proposals were considered favorably enough to earn a “Moderately Positive” level of approval. Proposals 8k, 8b, 8n, 8j, 8f, and 8e have favorability Index numbers within 0.13 of each other. If one assumed that implementation costs of these six development proposals differed, the EMYCIN technique gives results that suggest the city could win almost as much voter approval (or could please as many voters) implementing the least expensive option, even if it were the least favored of the six options, as it could implementing the most favorably rated option. Conversely, if the leadership of a city visioning project wished to encourage voters to approve a particular development option, perhaps because it was determined to be the most environmentally friendly of several

options proposed to solve the same problem, use of this EMYCIN technique of calculating and mapping Index numbers to the +1/-1 scale would allow the visioning leadership to determine the existing level of voter approval for the city's preferred option and target public relations campaigns towards improving voter understanding and acceptance of this preferred option.

The Index numbers also allow quick determination of where the most positive and negative responses occurred within and across questions, facilitating a clearer broad interpretation of responses and voter opinions behind them. For example, in question 2, only 4 out of 12, or 33.33% of the listed aspects of the city were rated positively, with the other 8 aspects, or 66.67% mapping out below zero if all points were plotted on the +1/-1 scale. The positive responses were only slightly positive. Responses to questions 3 and 4 both fell in the negative portion of the scale, with question 3 (how the city has progressed in the last 10 years) slightly more than "Somewhat Negative" and question 4 (how the city will progress in the next 10 years) hitting the scale at -0.1214. These responses point to an underlying current of dissatisfaction with most aspects of the city, disappointment with how city leaders have handled development in the last 10 years, and low expectation for significant improvements over the next 10 years.

Responses to all aspects of the city mentioned in question 5 generated positive Index numbers, indicating some level of "concern" about every one of these infrastructure and community problems, although none reached above the level of "Moderately Concerned" that would be indicated by an Index of 0.5 on the +1/-1 scale. Factoring these results in with the results of the first three questions, one could surmise

that these issues represent an expanded view of concern over some of the known negative issues in the city, and that voters are willing to express their level of concern over these issues but their expectation of seeing any improvements over the next 10 years is low.

Both question 6 (does the city need a general plan) and question 7 (likelihood of voting for a candidate offering strong development guidelines) rated between “Somewhat Positive” and “Strongly Positive”. These results might be interpreted to suggest that a general plan for the city would be favored by voters, and that a candidate talking development would be somewhat favored, but would not necessarily gain voter approval easily, given the disappointing history of development in the city and the voters’ low expectations for any future improvement.

All development proposals suggested in question 8 generated positive Index numbers ranking from just below “Somewhat Positive” to just below “Moderately Positive”. It appears voters would approve implementation of any of these proposals, although no one proposal is considered even “Moderately Favorable” at the level of +0.5 on the +1/-1 scale.

The Index numbers also facilitated the presentation of a ranking of survey responses by priority from highest to lowest. Table 16 below presents the ranking of Phone Survey issues within the same question, and the overall ranking within the survey, according to votes cast by the 1002 respondents.

Table 16. Ranking of Responses Using EMYICIN-calculated Index Numbers

Survey Question		
Q.2.	Ranking within Question	Overall Ranking
a. Job opportunities	7	37
b. Public school quality	4	33
c. Arts/culture opportunities	1	26
d. Air quality	12	43
e. Public safety/crime control	9	39
f. Racial/ethnic relations	6	35
g. Green space/parks	5	34
h. Recreation opportunities	3	32
i. Health care for low income citizens	8	38
j. Drainage/flood control	11	42
k. Mobility in city	10	41
l. The city as place to live	2	29
Q.3. In the last 10 years, has the city gotten: (Better, worse, or the same)	— —	40
Q.4. In the next 10 years, will the city become: (Better, worse, or the same)	— —	36
Q.5. How concerned are you about:	Ranking within Question	Overall Ranking
a. Difficult to get around	3	11
b. Deteriorating neighborhoods	4	12
c. Too many below poverty line	2	8
d. Shortage of affordable housing	9	19
e. Inadequate public education	1	6
f. Shortage of public parking	6	15
g. Loss of open space to development	5	13
h. Shortage of good public transport	8	18
i. Shortage of nearby park space	10	27
j. Insufficient city/suburban cooperation on problems	7	16
k. Low neighborhood diversity	11	28
l. Lack of local vision/planning	12	30
m. Need more sidewalks	13	31

Table 16 continued

Survey Question	Ranking within Question	Overall Ranking
Q.6. Some cities have general plan to guide future growth, but the city does not. How do you feel about creating a general plan for the city?	--	3
Q.7. Likelihood of voting for a candidate offering strong development guidelines?	--	5
Q.8. How do you feel about the following development proposals?	Ranking within Question	Overall Ranking
a. More bicycle paths	12	23
b. Stronger restrictions on development in flood plains	2	2
c. Business tax incentives for locating in depressed areas	7	14
d. Using public funds to restore historic buildings	11	22
e. Using public funds for parks	6	10
f. Green space/wetlands off limits to development	5	9
g. Increasing express bus service	9	21
h. Additional rail transit	13	24
i. Street/highway widening for more traffic	14	25
j. More curbside recycling	4	7
k. Imposing new regulations to reduce air pollution	1	1
l. Expand frequency and routes for bus service	10	17
m. More control of land use and urban sprawl	8	20
n. Make it easier to walk in city	3	4

The within-question rankings shown in table 16 have been discussed in some detail earlier in this analysis. On the other hand, the overall rankings present some interesting issues. Besides the potential usefulness of seeing every aspect of the survey prioritized according to respondent votes cast, some specific comparisons can be made. For example, recalling that responses to question 5 are positively weighted to indicate



the “importance” level of a negative emotion, “concern”, one can see from the ranking that the significance of voter concern about inadequate public education (question 5.e.) is much higher than the positive level of voter opinion about issue 8.h., the need for additional rail transit, issue 8. In fact, voter concern about inadequate public education is higher than positive responses on all development proposals offered in question 8, with the exception of the need for stronger air quality regulations (question 8k), the need for stronger restrictions on development in the flood plains (question 8b) and the desire of the voters for easier walking in the city (question 8n).

Another example of information available through this kind of ranking is that related to voter concern about shortage of public transport (question 5.h) ranked 18<sup>th</sup> in priority or approval. Other than increasing the express bus services (question 8.g), the options presented in Question 8 as potential solutions to this shortage of public transport ranked in at 21<sup>st</sup>, 23<sup>rd</sup>, 24<sup>th</sup> and 25<sup>th</sup>, for more bicycle paths, additional rail transit, and widening streets and highways to accommodate higher vehicular traffic loads, respectively. Concern about too many living below the poverty line (8<sup>th</sup>) deteriorating neighborhoods (12<sup>th</sup>), shortage of public parking (15<sup>th</sup>) and shortage of affordable housing (19<sup>th</sup>) were, in fact, all ranked higher than was agreement with the need for additional rail transit.

### **B.2.c. Combining Statements Using EMYCIN Formulas**

The EMYCIN formulas were again used in pair-wise combinations to blend the overall weights of two different statements into one combined weight represented by a

new Index number that reflects the combination of the positive and negative weight of the statements. To blend two positive Index values, equation (3) is used, and two negative Index values are combined using equation (4).

This combination procedure is not limited to blending the weights of only two options. The EMYCIN procedure allows for the combination of any number of options; as long as each new option is added singly in a step that combines it in pair with the combined Index of all the previous combination steps, every combined positive and negative weight of every selected option can be incorporated.

For the purposes of this study, the pair-wise combinations of the Phone Survey questions started by combining the Index of the first two statements in each question. Each subsequent step paired the resulting Index of the previous combination with the Index of the next statement listed in the question, so that each step added one Index to the overall combination Index for that question. The final Index for the question thus included weights of all responses for every statement or proposal within that question.

The results of these calculations show that, as one adds a new positive Index to the combination, the weight of the combined Index increases in positiveness, and as one factors in statements having negative Index numbers, the weight of the combined Index decreases in positiveness.

As with other Index numbers, the innovativeness and key to the usefulness of Index of combined weights of different statements is that it can be mapped on the +1/-1 scale.

Table 15 above presents the pair-wise combination of all statements within each question of the Phone Survey.

In the case of question 2 where voters were offered the opportunity to rate 12 aspects of quality of life in the city, the combination of the Index for statement 2a. job opportunities (-0.2026) and statement 2b. quality of public schools (+0.0051) required the use of equation (5). The calculation generated a new combined Index “ab” of -0.1994. Thus, the combined positiveness or negativeness of these two issues for this city is slightly less negative than “Somewhat Negative” in the opinion of the city’s voters who participated in the Phone Survey.

In spite of the fact that voters considered cultural and arts opportunities to be in the neighborhood of “Somewhat Good” (Index of 0.1893 for statement 2c.), when combined with the earlier combined Index “ab” of -0.1994 by using equation (5), the calculation slightly increased the positive weight of the combination Index “abc” to a still negative -0.0127. Interpreting this number, voters who participated in the Phone Survey expressed the opinion that if one combines the issues of job opportunities, quality of public schools, and cultural and arts opportunities in this city, the overall weight of this combined opinion is very slightly negative.

Adding the Index of statement 2d. (-0.4986) related to air quality, the most negatively rated aspect of the city, to the combined Index “abc” required use of equation (4), and produced a new combined Index “abcd” of -0.5050. It can be seen that the inclusion of a very negative Index in the pair-wise combination pulled the earlier slightly negative Index “abc” of -0.0127 to a more negative position -0.5050 on the +1/-1 scale.

Figure 12 depicts the placement of individual (yellow) and combined (blue) statements on the +1/-1 scale.

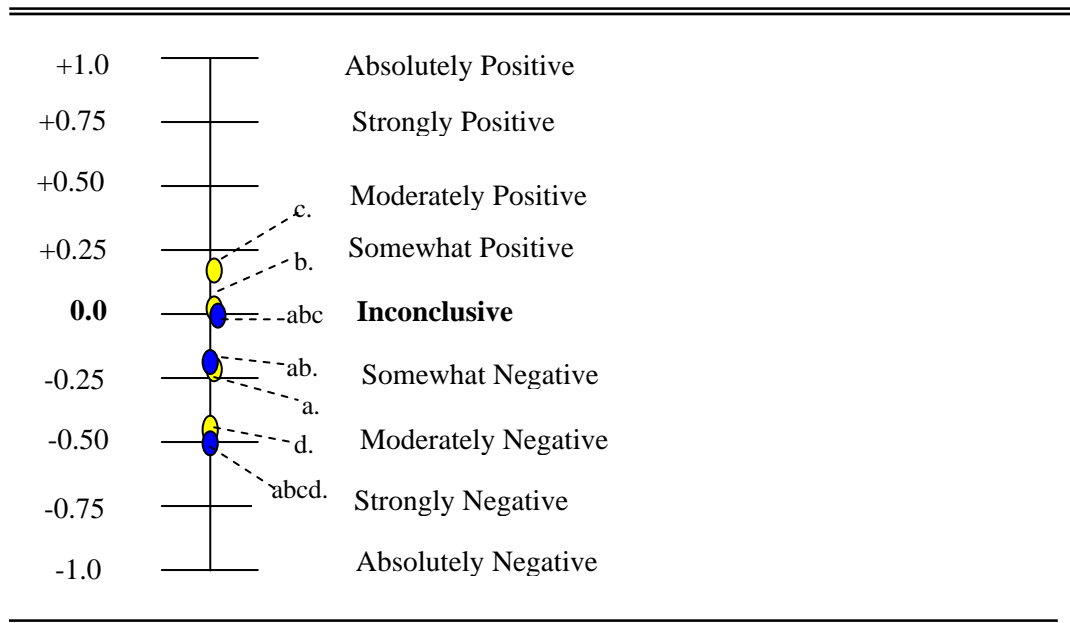


Figure 12: Phone Survey Question 2 – Four Responses with Combined Indices Mapped on Scale of +1/-1

In this way, continuing down the list of issues presented in question 2, the addition of each negative Index pulled the cumulative Index in a more negative direction on the +1/-1 scale. The addition of the few positive Index numbers moved the cumulative Index in a more positive direction. The addition of the Index of the final statement 2j, the quality of the city as a place to live, in pair-wise combinations produced a final combined Index “abcdefghijkl” of  $-0.9024$  for current quality of life in the city (shown in blue). This combined Index places well into the “Poor” range of the scale, and approaches  $-1.0$ , the value of “Absolutely Negative”, as is shown in fig. 13.

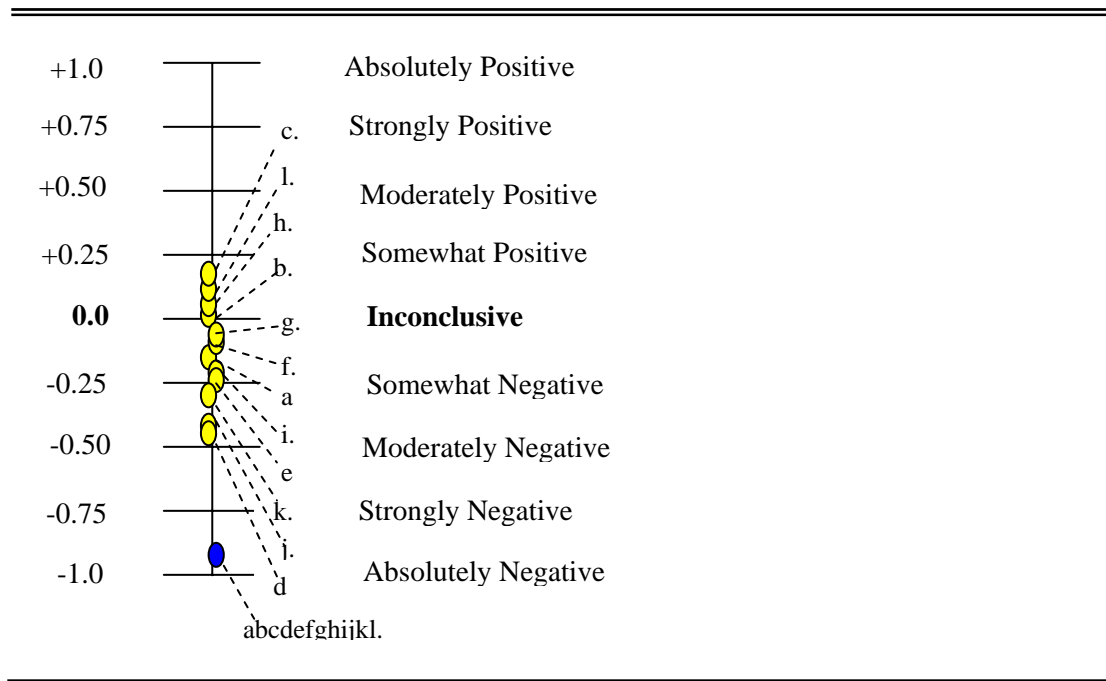


Figure 13. Phone Survey Question 2 Responses and Final Combined Index Mapped on Scale of +1/-1

The list of concerns presented in question 5 for Phone Survey participants were similarly combined in pair-wise operations. Beginning with combination of issue 5a., difficulty of getting around in the city, having an Index of +0.3184, and using equation (3) to combine it with issue 5b., deteriorating neighborhoods (Index of +0.2943), the combined Index for question 5 “ab” is calculated to be +0.5190. Mapped on the +1/-1 scale, the combination of these two concerns creates an Index that is more positive (i.e., of higher concern) than either of the two individual statements. It is of note that just the single pair-wise combination of only these two concerns, getting around in the city and

the deterioration of neighborhoods, places the combined concern Index at a point already slightly higher than of “Great Concern”.

Addition of the next area of concern, issue 5c. (too many living below the poverty line, with an Index of +0.3352), to the combined Index “ab” of +0.5190, using equation (3), once again produces a new combined Index “abc” of +0.6803. Using this stepped pair-wise combination operation only one more time to add the Index (+0.2572) for the concern 5d. related to the shortage of affordable housing, the combined Index “abcd” of +0.7625 had arrived at the level of “Very Great Concern”. Figure 14 presents the placement of the Index numbers for individual concerns a, b, c, and d (yellow), and the combined Index for “ab”, “abc”, and “abcd” (blue).

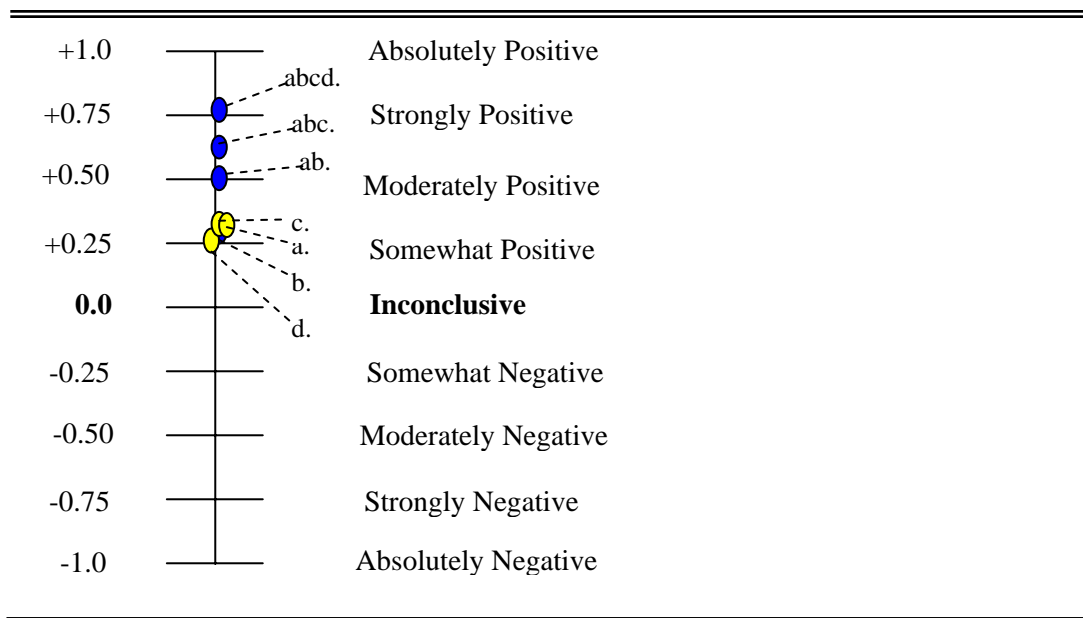


Figure 14: Phone Survey Question 5 – Four Responses and Their Combined Indices Mapped on Scale of +1/-1

The combination of statements of concern to voters in question 5 produced an overall combined Index of 0.9710. Recalling that this represents the weight of the negative “concern” experienced by voters, one may see that the overall Index for the concerns presented in question 5 somewhat parallels and confirms the negative overall combined Index of  $-0.9024$  for quality of life aspects of the city mentioned in question 2. Thus, whether at the level of the individual statement, the level of the block of combined concerns, or at a more complex level still, the EMYCIN technique provides the ability to compare and combine one-number Index numbers mappable to the  $+1/-1$  scale. The individual concerns and the final combined Index for all concerns presented in question 5 are shown in fig. 15.

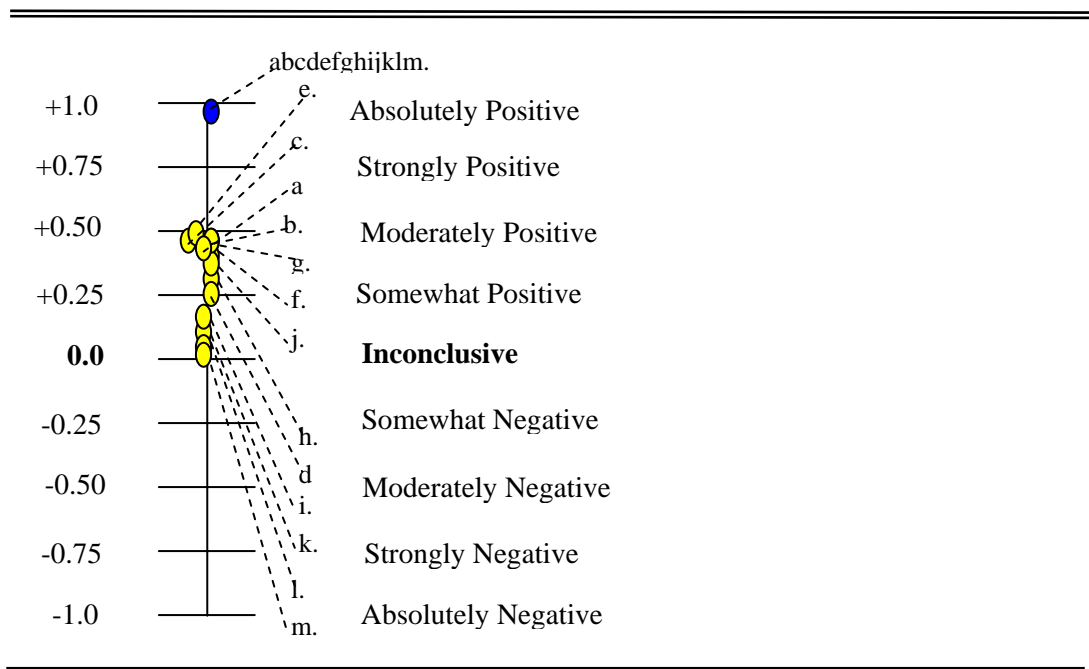


Figure 15: Phone Survey Question 5 Responses and Final Combined Index Mapped on Scale of  $+1/-1$

The development proposals offered for voter reaction in question 8. arose out of a series of public meetings involving citizens, visioning task force leaders, neighborhood association representatives, city leaders, businesspeople, and other stakeholders in the process of envisioning a desirable future for the city. Voter opinion on all proposals was therefore positive; therefore combination of any two proposals increased the positiveness of the “Favorability” Index.

Beginning with proposal 8a. related to increasing the number of bicycle paths (Index of +0.1974) and combining it with proposal 8b. promoting stronger restrictions on development in flood plains (Index of +0.4298), use of equation (3) to combine the two Index numbers gave a new combined Index 8“ab” of +0.5423. Thus, if city leaders were to propose a combined program that offered implementation of these two proposals, overall voter approval rates would be more than “Moderately Favorable”, as compared to the individual rankings of the two proposals, both of which were less than “Moderately Positive” and one of which was less than “Somewhat Positive”. It can be noted that by combining a more strongly positive Index with a less strongly positive Index, the less positive Index still had the effect of pushing the other Index to a still stronger positive position on the +1/-1 scale.

Adding the Index for proposal 8c. that puts forward the idea of business tax incentives for locating in depressed areas of the city (Index of +0.2890) to the earlier combined Index 8“ab” through use of equation (3) gave a new combined Index “abc” of +0.6746. Again, when combined with the less positive Index of +0.2890, the more



positive Index “ab” of +0.5423 was pulled towards the positive end of the scale to a combined Index more positive than either of the two individual Indices.

With the addition of the Index for proposal 8d.that suggests the use of public funding for restoration of historic buildings (+0.1987) to the combined Index “abc” of +0.6746, the new combined Index “abcd” is pulled more positively to +0.7393, or almost to the level of “Strongly Positive”. Figure 16 below displays the four individual Indices (yellow), and the three combination Indices (blue) to demonstrate again the additive nature of the combination of these particular positive Index numbers.

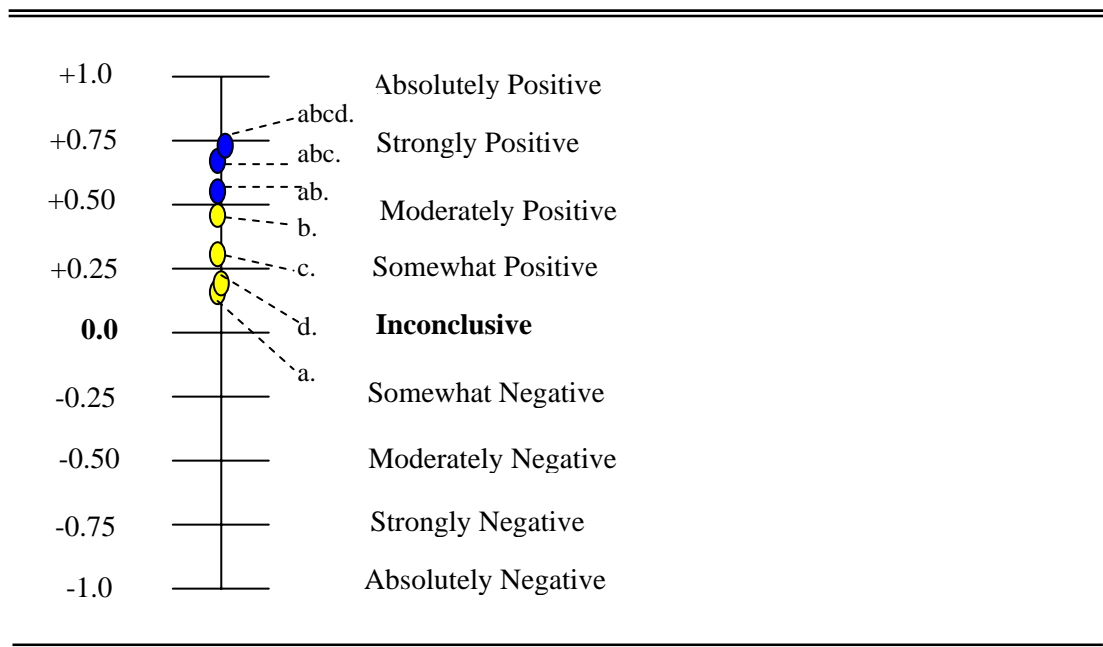


Figure 16. Four Question 8 Responses and Combined Indices Mapped on Scale of +1/-1

When the calculated Index numbers are combined for all proposals in question 8, the total combined Index for this question comes out at an extremely positive +0.9932 that falls just short of +1.0 or “Absolutely Positive”. This is depicted in fig. 17.

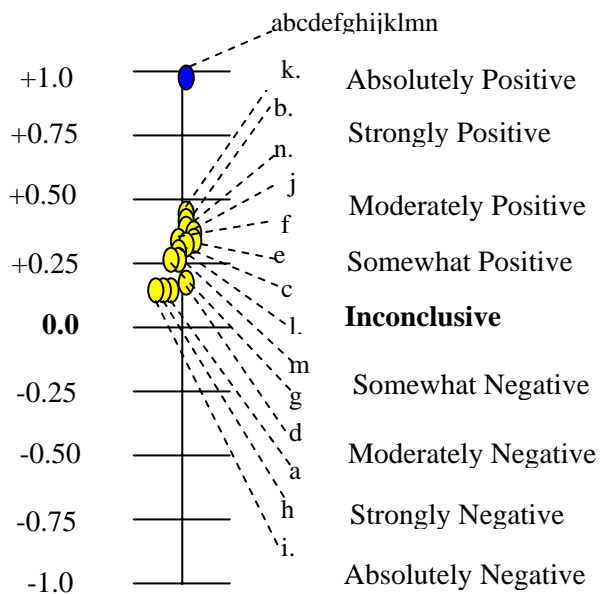


Figure 17. Phone Survey Question 8 Responses and Final Combined Index Mapped on Scale of +1/-1

It can be seen that by using the EMYCIN technique of combining statements, a powerful planning tool emerges for analyzing the significance of potential voter approval from implementing any select set of actions. Take, for example, only the three top-ranked proposals for action in question 8. Combining the favorability Index numbers for proposal 8k. (+0.4486) related to new air pollution controls, proposal 8b. (+0.4298) related to stronger restrictions on development in flood plains, and proposal 8n. (0.4109) related to making it easier to walk in the city, with each Index slightly less than the moderately positive weight of 0.5000, the two pair-wise calculations to incorporate these three proposals gives a combined Index “kbn” of +0.8148, indicating a

strongly favorable weight for the combination. Fig. 18 below depicts the individual weights (yellow) and combined positive weight (blue) of the three select proposals.

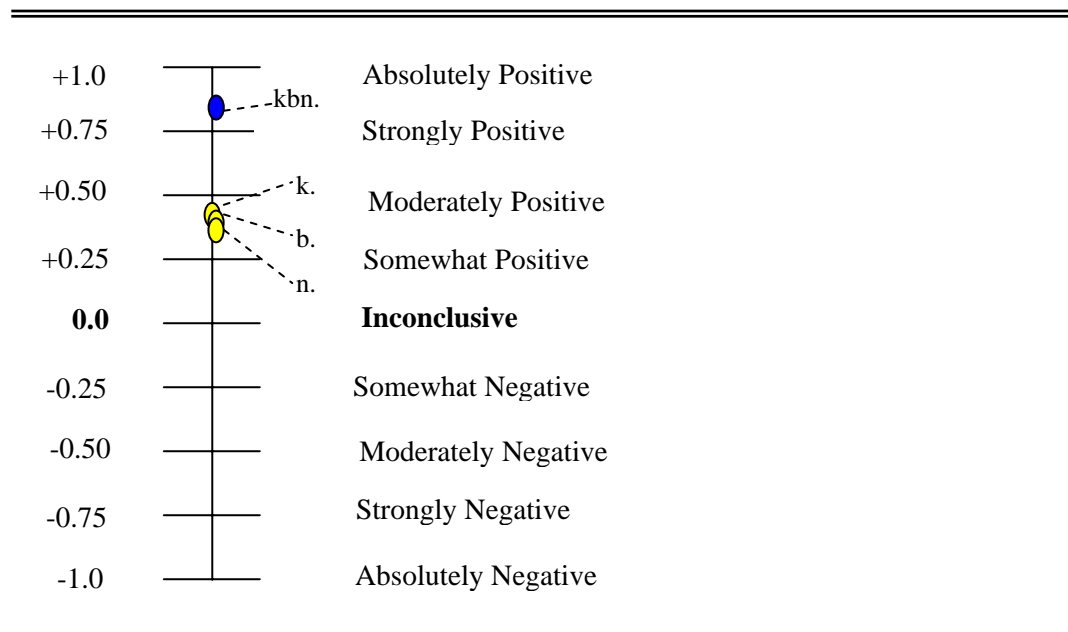


Figure 18. Phone Survey Question 8 Proposals (b,k,n) and Their Combined Index Mapped on Scale of +1/-1

Alternatively, if leaders of the visioning process were interested in identifying one or several actions for development of an implementation plan, a close assessment of the Index numbers for individual proposals in question 8 would point to the options offering the strongest positive ratings, or the shortest possible project completion time, or the lowest level of energy consumption, or the broadest possible spatial distribution in the city, that could be combined to produce even higher positive response from citizens.

In considering another possible planning scenario, perhaps the city's general fund budget for development may be consumed primarily in addressing the new regulations to reduce air pollution (proposal 8k) that would have to be coordinated at state and federal

levels. The cost of implementing proposal 8b., developing stronger restrictions on development in the flood plains, will far exceed the allocated budget for such policy activities. However, perhaps the healthier public works and infrastructure budget will allow strategic targeting of improvements. Combination of proposal 8k.(Index of +0.4486), proposal 8n. concerning making it easier to walk in the city (Index of +0.4109) and proposal 8e. suggesting use of public funds for parks (Index of +0.3190) would produce a combined favorability Index of +0.7788. This overall favorability weight is less positive than that for the combination of the three top-ranked proposals, but is still more than “Strongly favorable” at 0.75 on the +1/-1 scale, and may be affordable and possible to complete in a designated timeframe. Fig. 19 below shows individual Indices (yellow) and the combined Index 8“kne” (blue) on the scale.

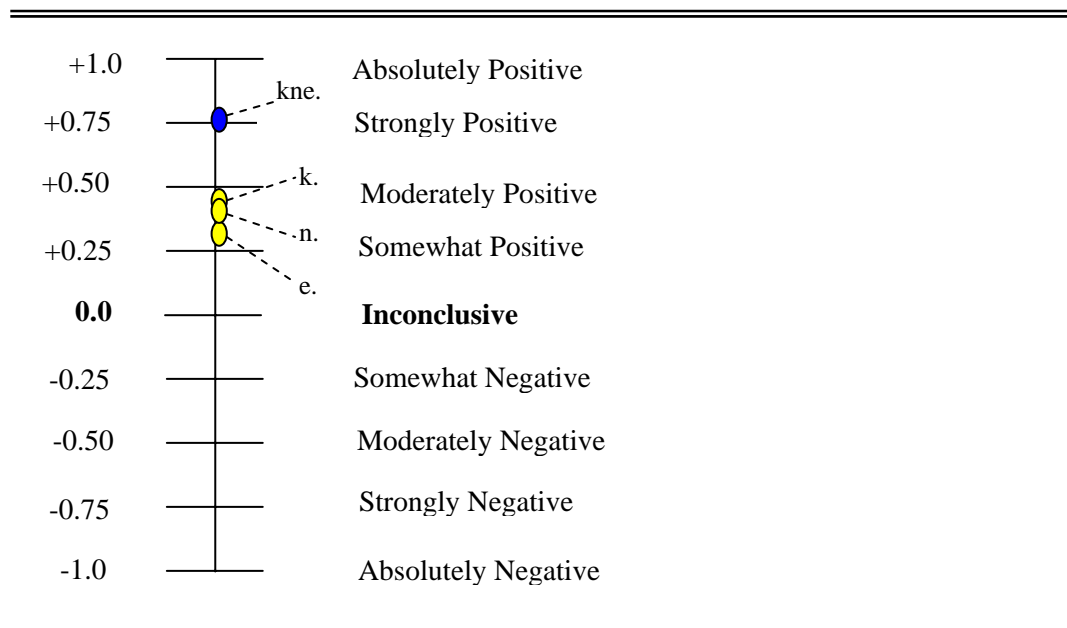


Figure 19. Phone Survey Question 8 Proposals (k,n,e) and Their Combined Index Mapped on Scale of +1/-1

In this way, it can be seen that the EMYCIN technique offers promise for planning activities where there is a need to identify and combine most appropriate options for action.

#### **B.2.d. Combining Unlike Elements**

In the same way that the EMYCIN equations were used to combine statements or options within the same question, these equations can be employed to evaluate or compile a set of dissimilar options. Because the Index numbers are quantitative and unlimited by content, issue, or dissimilarity of the statements that generated the Index numbers, this aspect of the EMYCIN procedure serves as a transparent and flexible tool for combining very different scenarios or opportunities to generate new information for assessing planning options.

As a simplified example, assume that the visioning project leaders in this city recognized the need to address citizens' concerns about the poor quality of change over the last 10 years and the expectation about the quality of change over the next 10 years, and to convince the city government to work together to create a general plan to guide growth in the next 10 years. In addition, assume they decided to identify some priority areas of focus for short-term investments in the city, and recalled that an issue in question 2 rated more than "Somewhat Negative" as an aspect of quality of life in the city was "Mobility in the city". In question 5, the issues of difficulty in getting around (Issue 5a), shortage of public parking (Issue 5f), and shortage of good public transport (Issue 5h) all received survey responses that resulted in Index numbers greater than

+0.25, meaning that they are all more than “Somewhat of a Concern”. The need for more sidewalks (Issue 5m) was also a voter concern, although, with an Index of +0.0494, was less so than the other three mobility issues. To address the issue of the need for improved mobility in the city, which in turn may have a positive impact on job opportunities for some (Issue 2a having an Index of  $-0.2026$ ), it was decided that the new general plan should include development of more bicycle paths (proposal 8a, which had an Index of +0.1974), increasing the express bus services in the city (proposal 8g, with an Index of +0.2539) and also adding routes and buses to the existing normal bus service (proposal 8l having an Index of +0.2781), as well as developing additional rail transit (proposal 8h with an Index of +0.1958) and making it easier to walk in the city (proposal 8n, with an Index of +4109).

Given that some of these transportation activities might contribute to air pollution, the aspect of the city’s quality of life rated most negative of all the issues presented in question 2, assume the city government agreed to work with state agencies and private industry to work on new, more stringent controls of smokestack emissions and other sources of air pollution in order to develop and impose “New regulations to reduce air pollution”, mentioned in question 8 as the most highly favored of all proposals for development in the city. This work could, for example, include switching a percentage of the city’s bus fleet to less polluting fuels, and working with transportation experts to explore electric or other fueled light rail as an alternative to higher-emission fueled trains.

Table 17 below shows the elements of the Phone Survey selected for this hypothetical development strategy.

Table 17. EMYCIN Calculations for Combination of Unlike Phone Survey Elements

	Range	Index	Pair-wise Combination	Elements Combined
Q.6. How do you feel about creating a General Plan for the city?	0.9400	0.4148		
Q.8. How do you feel about				
a. More bicycle paths	0.9701	0.1974	0.5303	Q6**8 <sup>a</sup> (1st)
g. Increasing express bus service	0.9202	0.2539	0.6496	Q6, 8a**8g (2 <sup>nd</sup> )
h. Additional rail transit	0.9301	0.1958	0.7182	Q6, 8a, 8g**8h (3rd)
k. New regulations to reduce air pollution	0.9800	0.3663	0.8214	Q6, 8a, 8g, 8h**8k (4th)
l. Expand frequency and routes for bus service	0.9202	0.2781	0.8711	Q6, 8a, 8g, 8h, 8k**8l (5th)
n. Make it easier to walk in the city	0.9401	0.4109	0.9241	Q6, 8a, 8g, 8h, 8k, 8l**8n (6 <sup>th</sup> )

To determine the positiveness of this plan, the EMYCIN equations were again used to combine the Index numbers for each individual aspect of the plan. Beginning with the question 6 Index of +0.4148 (“Somewhat Favorable”) approving the development of a general plan for the city, and using equation (3) to combine this positive Index with the positive Index of +0.1974 (“slightly less than Somewhat Favorable”) for question 8a development of new bicycle paths, the new combined Index for question 6 and question 8a was calculated to be +0.5303. This puts the combined Index just above the level of “Moderately Favorable” in terms of voter opinion.

The next pair-wise combination to add the other question 8 proposals continued with the Index for proposal 8g, increasing express bus services. The 8g Index of +0.2539 was combined in a pair-wise operation with the combined Q6, Q8a Index of

+0.5303 to give a new combined Index of +0.6496. The next addition combined this new Index of +0.6496 with the Index for proposal 8h (increasing rail transit) to arrive at a new combined Index of +0.7182, or almost to the level of “Strongly Favorable”. Continuing to add the rest of the question 8 proposals selected for the plan in pair-wise operations, the final Index for the plan was calculated to be +0.9241.

Given the transparency of this process, planners may seek to try various options for combination of proposals to achieve a certain level of approval, perhaps considering not only the approval Index for each proposal but also the amount of time and funding required to complete the plan if differently configured. For example, given that the Index +0.4109 of proposal 8n (making it easier to walk) is much higher than the Index +0.1958 of proposal 8h (additional rail transit), promotes walking, a low-emission mode of transport, and adds the extra benefit of promoting citizen fitness, and may in addition be less expensive than expansion of the light rail system, vision project leaders may strategize to add proposal 8n at the beginning, determine the gain in favorability, and then selectively add other proposals until the target for citizen approval is achieved.

Figure 20 presents the individual Index points for the strategy presented above to develop a general plan, as well as the combined Index for the overall plan.



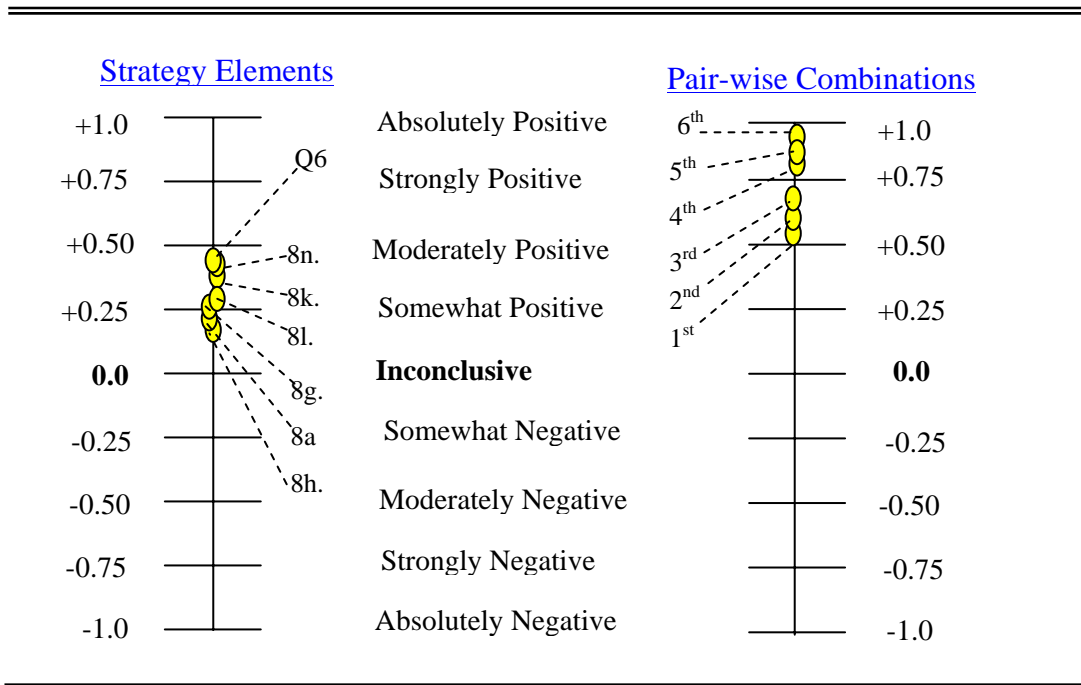


Figure 20. EMYCIN Evaluation of General Plan Strategy, Mapped on Scale of +1/-1

It can be seen from this example that the EMYCIN pair-wise methodology serves as a tool to create a variety of products, including an evaluation of conditions and progress, as in the transformation of the citizens' congress and phone surveys. But it can also be used in a different way, as described above, to develop a targeted plan of action. Stated differently, the EMYCIN methodology of pair-wise combination of unlike elements offers both an evaluation and a planning tool.

## **CHAPTER V**

### **CONCLUSIONS AND LIMITATIONS**

#### **A. CONCLUSIONS**

Although definitions abound for “sustainable development”, the simple definition that emerged from the World Commission on Environment and Development (UNWCED 1987) and that has become widely used as the reductionist version of a complex process states that sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Lee notes, in reference to the developing countries, that allowing the poor to have a say in the resolution of local environmental problems in urban environments would carry us a long way towards addressing the “needs of the present” component of sustainably developing our planet (Lee 2007, 18). Over the longer term, it will be necessary to invest in infrastructure, services, policy, and education to build urban communities that address the needs of the future. A key element of the sustainability of the future of any community, and particular those in expanding and increasingly overburdened urban environments around the world, will be the extent to which the needs and preferences of the members of these communities are built into master plans with the objective of ensuring maintenance of sufficient resources of good quality for future generations.

Community-based planning has emerged in many developed countries as one mechanism to achieve this objective. However, as noted by the National Civic League (2000), the results of community-based visioning surveys are more likely to be filed away than to be used as foundations for planning development. This study investigated the question of whether the EMYCIN procedure for transforming citizen opinion survey results that are highly descriptive, into quantitative data that can be ranked, compared and combined, may provide a new tool that would allow planners to more easily use citizen opinion survey results as the basis for community development planning.

The study answered this question by demonstrating that the responses to opinion survey questions formulated using several structures can be transformed, using a logical, transparent and duplicable procedure, from data stated in a descriptive format, such as percentage of responses in agreement or disagreement, into quantitative data that can be mapped on a simple scale from  $-1$  to  $+1$ . Further, the study demonstrated that specific new information emerged concerning the overall positive or negative weight of the response for each survey question, compared to information apparently available from survey response tallies. In addition, the new information took a form that allowed prioritization of survey participants' opinions by using one number to give a specific total positive or negative weight for each question. The study then demonstrated that the single numbers could be used easily in developing rankings, comparisons, and combinations of proposals for action plan development.

A number of conclusions can be derived from the results of this study. The calculation of the Range for each survey question provided an indication that valuable

data is lost during procedures commonly used to analyze and interpret opinion surveys because the non-responses are seldom discussed and appear to not be taken into consideration. When using the EMYCIN technique, the Range is calculated to reduce the total percentage of responses by a number proportional to the number of non-responses, so that one is provided with a Range number that specifies the percentage of respondents who cast a vote. In the case of the citizens' congress, the Range represented the number of survey participants who cast an "opinion" vote rather than a "Neutral" vote that was counted as a "no-opinion" vote. In the case of the Phone Survey, the questions took several forms, but in all cases the Range represented the percentage of respondents who cast opinion votes, and eliminated those who either did not respond or who cast "Neutral" votes. In the case of both surveys, the Range number gives an indication of what percentage of the respondents answered the question, and the percentage who did not, for reasons that may be related to the importance of the issue to survey participants, the complexities of the issue that may not be well understood by survey respondents, or possibly the unclear formulation of the question. The key is that, in every case, the zero weight of these "non-responses" is calculated into the overall positive or negative weight of each question through use of the Range in calculating the Index, so that no data is lost.

The EMYCIN allows calculation of single numbers for the Index and combined Index, both of which give specific new information about voter opinion on the individual survey question issues or proposals. While one alternative methodology was found that generated an "Importance-Satisfaction" or IS, index of one number, this methodology

appears to have not counted the value or weight of “non-response” votes, thus causing a potential loss of important data from the survey responses. The EMYCIN-calculated Index indicates the exact positive or negative weight of the survey question, based on every vote cast concerning that question, including the “neutral” and “no-opinion” votes whose zero weights are included in the calculation of the Range. Building on this foundation, the combined Index provides a precise positive or negative weight for the specific combination of two or more issues or options. These numbers can be presented in a table format that is easy to understand, and in a graphic format on a +1/-1 scale that sends a clear visual image of the positive or negative weight of each element, and how the elements compare or are ranked against each other.

It may be important for visioning project leaders to understand the influence of neutral votes, since they may indicate a number of possible scenarios, including that voters do not understand the issue presented in the survey, that voters have no opinion on the issue, that they have equal amounts of positive and negative feelings about the issue, that they do not understand the survey question, that they have some reservation about indicating their views on the issue, or that they have equal amounts of positive and negative opinions on the issue, among others. If the survey is intended to be used to collect voter preferences for specific development action plans and scenarios, high levels of neutral votes could result in the neutralization of development options offered to the citizenry that might otherwise be considered extremely unfavorable, or elimination of improvements voters would otherwise consider desirable. Understanding the significance of the information provided by the Range may allow visioning stakeholders

to reformulate survey questions about issues that resulted in high numbers of neutral responses or non-responses.

Rankings developed using the EMYCIN-calculated Index numbers, if compared to those generated by combining the two top positive response categories, typically “Very Good” and “Good”, provide very similar results, with some exceptions. The difference between the two ranking methods is found in the actual level of approval for each statement, no matter where it falls within the ranking. For example, Question 2c of the Phone Survey asks citizens to rate the local arts and cultural opportunities of the city. The combination of 25% “Excellent” votes and 44% “Good” votes tallies to a 69% response that the arts and recreational opportunities in the city are very good or good. This and one other issue, the city as a place to live, which also gained 69% response that the city was an excellent or good place to live, would share first place in a ranking based on this combination of “Excellent” and “Good” votes. The consultant reported these results as the most positive responses, giving the impression that responses were in fact very positive. However, using the EMYCIN-calculated Index numbers to develop the ranking, the issue of local arts and cultural opportunities still ranks as first in the issues of Question 2, but places on the +1/-1 scale at only 0.1608. Using the EMYCIN technique for the issue of the city as a place to live generated an even lower Index number of 0.1176, and placed it in second place in the ranking, below the issue of arts and recreational opportunities.

Because the EMYCIN technique arose from an expert system devised to identify and quantify “certainty” levels of the component parts of every rule, each part of a rule,

the importance of each rule part influencing the entire rule is thus quantified in a defined way. In the application of the EMYCIN technique to community-based visioning, the certainty factors are assigned to each level of response (“Somewhat Agree”, “Strongly Disagree”) in a pre-defined and documented way. There are three distinct results of this aspect of the technique:

1. First, the weight of every vote cast for each question is calculated into the total positive or negative weight of the response (Index) for the individual questions, providing visioning leaders with a potentially powerful assessment tool. For example, in the case of Phone Survey Question 4, 43% of respondents felt that the city would improve in the next 10 years, and the consultant reported that this was more than the number of respondents who felt that conditions in the city would deteriorate (22%). But not mentioned were that 28% felt that things would remain the same, and 6% weren’t sure or didn’t have a response, for a total of 34%, or slightly more than one-third of the respondents, who gave a neutral response. Viewing the Question 4 responses through the filter created by the consultants’ interpretation would give the impression that overall voter responses were positive about the future of this city. By including the negative and the neutral responses using the EMYCIN procedure, it becomes clearer that these negative and neutral votes have a noticeable influence on the overall positive or negative weight of the response on this issue. The slightly negative Index (-0.1214) actually shows that the issue is a negative as far as the voters are concerned. Thus, no responses are eliminated or ignored, and thus no data lost. In contrast, the consultants’ evaluation of the original responses to both surveys considered in this study failed to incorporate

the significance of negative responses in their analyses, and appeared to not consider the neutral votes at all in their summary interpretations.

2. Second, every survey response, whether strongly positive, mildly positive, neutral, moderately negative or strongly negative, is given a clearly defined weight that is pre-defined and equally applied across the survey. Thus, as long as assumptions and specific weighting procedures are well documented, this process is not a “black box” but is completely duplicable. That is, the same survey results can be analyzed by another team using the same procedure and obtain the same results, and in the same way, the survey can be administered in the same format in another location or in the same location at a later time, and results analyzed using the same process, for comparison of results with those obtained from the first survey.

3. Third, because the scale that serves as a model for assigning weights to positions on a 5-point scale or 7-point scale that includes negative positions because of the zone between zero and  $-1$ , negative responses can be mapped to be shown as negative rather than less positive, as would be the case on a scale only from zero to  $+1$ .

The inclusion of the weight of neutral votes using the EMYCIN technique pushes both negative and positive responses towards zero, in effect moderating both the negativeness and the positiveness of a response. For example, 57% of Phone Survey respondents said they were more likely to vote for a candidate offering strong development guidelines. Only 10% said they were less likely. This gives the general impression that this response might correspond to a level around or perhaps slightly below  $+0.50$  if placed on a scale of 0 to  $+1$ . The consultant pointed out only that 57%



would so be influenced. However, taking the weight of the 23% of respondents who said strong development guidelines would make no difference in their vote for a candidate, and another 11% who were not sure or had no answer, a total of 34%, or more than one-third of the respondents, cast an inconclusive vote. The actual overall positive weight of this statement was calculated using the EMYCIN procedure to be +0.3784, lower on the positive end of the scale than the impression given by the consultants' summary.

The use of the EMYCIN technique as demonstrated in this study is founded on the initial use of more traditional survey analysis techniques. Thus, tallying the responses from an opinion survey can be viewed as a "first step" that produces a static picture of the situation of interest, and offers a comparison with earlier static pictures of the same situation of interest. This technique could be considered a reliable mechanism for monitoring changes in opinion, and is used for this purpose in community-based planning. It appears that, in the case of the subject city of this study, visioning process leaders were hopeful to use the opinion survey results to focus planning for development, but interviews with at least two stakeholders in the process confirmed that nothing had been done as a result of the earliest survey, the Phone Survey, and it remains to be seen if any action will be taken as a result of the later survey. By adding the "second step" of employing the EMYCIN technique, however, one can begin to see a possible method that shows potential for "leveling the playing field", as one stakeholder described it. In this case, responses to every survey question can be mapped to the same +1/-1 scale and compared for positive or negative weight along that scale. The positive

and negative weighting as expressed in the Index numbers offers all stakeholders a more clear vision of how people feel about the issues, which development proposals are preferred by survey participants, and how strongly they prefer (or object to) these proposals. This EMYCIN-generated information provide the basis for beginning the planning of development actions, should that be the interest of the community, even if the next step is to refine development scenarios offered in earlier surveys and submit them again for voter/stakeholder evaluation. Thus use of the EMYCIN technique offers the possibility of “adding value” of use to planners to citizen survey results that are analyzed and presented in more traditional ways.

Because the Index numbers are quantitative and unlimited by content, issue, or similarity of the statements that generated the Index numbers, this aspect of the EMYCIN procedure could be seen as offering benefit to community visioning stakeholders and urban planners. It serves as a transparent, flexible and duplicable procedure for combining very different scenarios or opportunities to create a variety of products, including a targeted plan of action or an evaluation of conditions and progress. Visioning stakeholders and urban development leaders could, with little difficulty, use the Index numbers calculated for related development options, but having different weights, to explore stakeholder opinion about a variety of options to solve a problem and identify the most popular solutions. Planners might use this tool for identifying the development actions having the highest voter approval rates, map these against costs to identify budget implications, map them against a variety of scales including the spread of impact across geographic locales, spread of impacts across socio-economic groups,

and other scales that would allow community stakeholders to optimize impacts. Thus, the EMYCIN procedure could be used not only as an assessment tool, but offers possible usefulness as a planning tool.

The same argument holds for the new information created by combining data of development options that have different focus and different positive or negative weights. Thus, the EMYCIN technique could be used to combine different and unrelated activities into a package of community interventions that would ensure benefits accruing across geographic areas and stakeholder groups.

Finally, the EMYCIN technique's logic, complete boundedness between  $-1$  and  $+1$ , and transparency suggest that the technique lends itself to adaptability to a wide variety of applications, including many aspects of planning and monitoring for sustainable development. The ease of transformation of survey responses into quantitative data that can be compared and combined point to the EMYCIN's possible use as a component of a rapid appraisal activity for a variety of focus areas.

## **B. LIMITATIONS**

The following limitations emerged during the process of applying the EMYCIN technique and evaluating the results.

### **B.1. EMYCIN Application to Other Survey Designs**

It is not clear whether the EMYCIN technique as demonstrated in this study may be useful in evaluating survey questions having other formats. For example, opinion surveys often ask respondents to rank a set of statements according to preference, from highest to lowest, or to select among a limited set of options as preferred resolution for a particular problem or development issue. Should the EMYCIN technique be determined by community visioning project stakeholders and planners to be useful in assessing stakeholder preferences and planning for development, opinion survey questions may be formatted during survey design to allow EMYCIN application.

### **B.2. Assumptions and Assignment of Weight**

If the EMYCIN technique is to be used, assignment of weights for categories of response should be carefully considered before finalizing survey designs. There are three reasons for this: 1) to ensure the logic of the responses; 2) to control the possibility of introduction of an element of subjectivity that would reduce the transparency and duplicability of the exercise; and 3) to allow combination of transformed survey responses in assessing and building an action plan.

As an example of the issue of ensuring logic of the responses, Phone Survey question 5 proposed a set of negative scenarios, and asked voters to indicate their level of “concern”. Because the survey designers clearly considered “concern” to be a

negative reaction to the scenarios being presented, logically the higher the “concern”, the higher the negativeness of the reaction to the issue. If one assumes “No Concern” indicates a “zero” level, the question for applying the EMYCIN technique to the question as originally formatted would become whether to assign positive or negative values to the levels of “concern” expressed. One would expect the Index numbers to have the same absolute values, whether on the positive or negative side of the scale, and this may not be a significant issue if the objective were simply to gain a snapshot of stakeholders’ opinions about the scenarios. However, if the responses were intended to provide planners with a set of issues of concern and a set of solutions, to be combined to meet community development objectives, it would be important to ensure that the responses for question 5 were of the correct polarity to be used in the combinations for development of an action plan.

If question 5 had been posed differently, such that voters had been asked how they felt about the issues, rather than how “concerned” they were, and if the options offered for responding had included “Very Good”, “Somewhat Good”, “Neutral”, “Somewhat Bad” and “Very Bad”, then a logical allocation of weights for these categories might have been +0.75 for “Very Good” votes, +0.25 for “Somewhat Good” votes, -0.25 for “Somewhat Bad” -0.75 for “Very Bad”. This difference in question formation and resulting difference in assignment of weights would have eliminated the question of whether to assign positive or negative weights. It also may have generated responses in a format that could more easily have been compared and combined with other components of the survey.

This constraint points to the possibility that surveys could be designed specifically to capture the information possible through use of the EMYCIN technique.

Concerning the issue of assignment of weight along the +1/-1 scale for varying levels of positive or negative response, the EMYCIN allows survey designers to control the subjectivity/objectivity of responses through the wording of survey questions and through assignment of weights to levels of responses. For example, the technique could allow leaders interested in influencing the outcomes of an opinion survey to influence the outcome of the process by assigning higher or lower positive or negative weights to categories of response. In fact, because certain levels of knowledge were required to assess symptoms and diagnose diseases, developers of the original rule base for the medical MYCIN system intentionally built this mechanism in, to allow medical experts to assign specific and varying confidence factors (or influence factors) to disease symptoms, representing their likelihood of indicating the presence of the disease.

In the case of community visioning, a stakeholder having a political or economic interest in pushing forward a particular set of plans for a community might propose a weighting system using +0.4 for “Somewhat Agree” and +0.8 for “Strongly Agree”, and the corresponding -0.4 for “Somewhat Disagree” and -0.8 for “Strongly Disagree. The survey could then be designed to elicit the responses that would generate results showing high community support for the set of development issues proposed in the survey.

While this capacity of the EMYCIN technique could prove useful in applying the technique to other evaluation processes, it could also allow the incorporation of bias into a community planning process.

This brings us to the third issue, that of comparability and “combinability” of responses from different surveys. While assignment of response weights other than the logical divisions along the +1/-1 scale as proposed in this study may be of use in some applications, it would also prevent comparison of same-question responses across different communities. For example, if one community used a scale that assigned +0.8 to the “Strongly Approve” response, +0.2 to the “Somewhat Approve” response, and used the same values on the negative end of the scale for “Somewhat Disapprove” and “Strongly Disapprove”, then there would need to be a procedure developed for equating these responses to those coming out of an opinion survey utilizing the scale divided as proposed in this study.

Thus, the decisions concerning assignment of polarity and level of weights to response categories will affect overall results from use of the EMYCIN technique, and could introduce an element of subjectivity that would reduce the transparency, reduce comparability and duplicability of the exercise. Weight assignment should be carefully considered in the development of the survey, and then clearly explained in the methodology used to interpret results.

## **C. RECOMMENDATIONS**

This study has identified a new technique for evaluating opinion survey results. The data generated by the application of this technique presents new information not available from the survey results in their original tally formats. While it appears that the

technique is not easily applicable to survey questions structured in some formats, there is an implication that surveys intended for analysis and interpretation using the EMYCIN process of data transformation may be designed specifically to allow this interpretation, so that new information may be generated from the survey tallies currently in widespread use to determine citizen opinions.

Recommendations for further research on application of this technique include:

- Investigation of developing surveys structured to use the EMYCIN technique and to take advantage of the quantitative outcomes in application of survey responses to develop a plan;
- Investigation of usefulness of EMYCIN-based survey results in developing a budget for the community development plans whose support is indicated by survey results;
- Investigation of a process for developing confidence intervals around the Index number for survey responses;
- Investigation of the weighting and prioritization process for application of this technique.



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